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RAPID TRANSIT SCHEMES FOR THE METROPOLIS.

THE relief of the street traffic of London is one of the most pressing questions of the day, as far as its citizens are concerned, and it is high time that serious efforts were made to remedy the existing difficulties. There is no space for railways in this huge city, but deep down below the foundations of houses, below the sewers, and other underground works, there is yet room. Mr. Greathead, with the South London Subway, has shown us how the thing can be done. The City Central Railway, in consequence of the success on the South London, has this year obtained Parliamentary sanction to build a similar but larger line between the City and the West as far as Shepherd's Bush. This line will be an immense boon to the most congested thoroughfares, such as Cheapside, Newgate Street, and the narrower portions of Oxford Street; it will be of incalculable advantage to the business man, who not only wants to get from east to west, but who wishes to get there and back within a reasonable time. At present, one never knows how long it will take to get through the above-named streets during the busiest parts of the day by cab or by 'bus.

There is no less need of communication between other points of the Metropolis, and, indeed, we look forward to the day when underground railways will radiate from some central point in various directions coming in touch with important main line termini and with the Metropolitan and District Railways. Several Bills are about to be promoted in Parliament this session dealing with this question, one of the first being that of the Waterloo and City Railway Company, intending to connect the Mansion House with Waterloo Station by means of a subway containing a railway to be worked either by electricity or by cable. No one can question the necessity of such a line, and we trust that any opposition to this Bill will be removed in an expeditious and businesslike manner.

Then there is the Royal Exchange and Waterloo Railway, intended to run, underground, to London Bridge as well as Waterloo Station, as a feeder to the South Western and the Brighton Company. There is also the Baker Street and Waterloo Railway which would pass under the Thames from Lambeth, so as to touch Charing Cross, by way of the Haymarket and Portland Place, to a point near Baker Street Station. It seems a pity that the projectors of these lines do not aim at connection with the termini of our important northern trunk lines, and with the Great Western. The City and South London Company will again seek powers to extend their line by a subway to Islington by way of Moorgate Street and the City Road. Another underground line, called the Hampstead, St. Pancras and Charing Cross Railway, has also been proposed, which is to have a branch to Euston, St. Pancras and King's Cross. Furthermore, it is proposed

by the Great Northern and City Railway Company to connect, by a tunnel, the Finsbury Park and Canonbury branch of the Great Northern Railway, terminating at Finsbury Pavement. We plotted these lines upon a map of London, and came to the conclusion that their purposes will not be fully served unless all the ends terminate at other railway stations in such a manner that passengers need not come out into the streets in order to change from one line to the other. It would be a great advantage, for instance, if the City termini of several of the above-named lines were directly connected either by subways, or, better still, by one large underground station, say, in front of the Mansion House underneath the open space, or at some other convenient junction.

In all these cases any motive power but steam is asked for, but it is nearly certain that electricity for purposes of traction will be used in each. It has been established beyond all doubt, thanks to the enterprising spirit of the City and South London Company, that electric energy satisfies best the conditions of subterranean service, and it is now solely a matter of improving details to make electric motors not only the most convenient, but also the most economical and reliable means for propelling the cars. In spite of sundry small mishaps and delays on the City and South London line, it has well maintained its popularity, and with the experience already gained there, we feel sure that the same system can be worked to perfection elsewhere.

ON THE CANDLE-POWER OF INCANDESCENT LAMPS AS RELATED TO CURRENT, VOLTAGE, AND ENERGY CONSUMED.

THE July number for the current year of the American publication, *Technology Quarterly*, contains a paper on the above subject by Messrs. Louis A. Ferguson and David A. Center. The object these investigators had in view was to determine, with a number of lamps of modern make and from different manufacturers, the relation which exists between the candle-power and the current, the electromotive force, and the electrical energy, or watts, according as these are varied throughout a wide range, and to contrast the results with those obtained by others who had employed lamps of earlier manufacture. The limits of the readings ranged between a decimal of a candle-power and the point at which rapid disintegration of the filament commences, and where the light emitted ceases to increase in a corresponding degree with an increase of energy. We will not follow the authors through their mathematical exposition, but quote the brief conclusion arrived at:—"The lamps at present used, like the earlier ones, increase in candle-power about as the fifth power of the current, and as the cube of the energy expended. It will also be seen that the candle-power increases about as the sixth power of the potential difference between the terminals of the lamp. The average value of the exponent of x, the candle-power for the current equations, is 5·3; for the energy equations 2·9, and for the potential difference equations 6·4."

In the course of obtaining the numerical data at the different stages of incandescence, one or two observations were made. Thus, after the readings at the desired degree of incandescence had been recorded, those lamps whose filaments were still sound were again subjected to the same treatment, and in every instance the curve of relation ran lower than in the first test, *i.e.*, more energy was required to produce the same candle-power. It would have been surprising if this had not proved the case.

The following remarkable experience is worthy of being quoted in full:—"It was found in a few instances where it was impossible to finish a test of the lamp on the same day that it was begun, that on resuming the test it required more energy per candle than on the first day, until after some 15 minutes had elapsed, when the original values were again obtained. This is clearly seen in the Thomson-Houston 32 candle-power 52-volt lamp, denoted in the tables by the letter M." The readings of this lamp before and after the interval are as follows:—

2·98 ampères	72·17 volts	215·1 watts,	139·2 candle-power.
3·01 „	71·89 „	216·4 „	117·5 „

It is difficult to conceive how such a result can occur, *i.e.*, if the incandescent lamp is the cause. It is true the resistance had altered a little—a by no means unusual circumstance—but this should not affect the light emitted, since the energy was kept practically the same. Is it possible that there was at first an increase in the illuminating power of the Methven standard light which was used in the tests? If so, this would account for the result; but it is almost equally difficult to explain how such an increase should arise. A decrease might be more easily accounted for, *e.g.*, from admixture with air.

Another feature especially interesting to lamp manufacturers was that nearly every make of lamp seemed to have one particular part at which the filament gave way. The Edison filaments broke in every instance, except one, within half an inch from the platinum joint on the right-hand side, when looking at the labelled side of the bulb. This fact was, unfortunately, not noticed until the circuit wires had been removed, so that it is not known whether the fracture was on the negative or positive side. The Weston filaments always broke about 1 inch from the top, while those of the Thomson-Houston broke at the top.

As a matter of some interest, the experiment was made on a number of Edison lamps (candle-power not stated) to ascertain what amount of energy was required in order that the first appearance of light might be just distinguished in a positively dark room. The result was, that the most sensitive observer first saw the filament when an energy of about ·74 watts was being expended. The colour of the light is described as being of an ashen grey in all cases.

ENGLISH MANUFACTURES AT THE WORLD'S FAIR.

ENGLISHMEN who have read the modern history of their own country must be aware that there was a time when English manufactures commanded the markets of the world, and this in consequence of both excellence and comparative cheapness. Masters were not then hampered at every turn by the restrictions of trade unionism, a power which, entirely

justifiable in itself has, in the hands of unscrupulous and ignorant demagogues, well nigh driven legitimate trade from our shores, so that as a manufacturing power England, instead of being pre-eminent, is now scarcely able to hold her own in the face of American, German, and other competition. What have Mr. John Burns and others of his ilk to say to this undeniable fact? These gentlemen seek to raise the wages of those for whom they fight, and they leave to chance the probability of the increased selling price which must be put upon the wares manufactured, scaring away customers. For in the majority of cases competition is so keen that the small margin of profit which remains after everything has been paid for, only enriches the manufacturer when an immense volume of business is done, and the increase in wages simply wipes out the margin, and leaves practically nothing for the master—who has built up the business—to work for. In the meantime the Continental manufacturer, who can command cheap labour, sells cheaply, and the foreign consumer naturally prefers to buy non-English goods cheap rather than English goods dear, provided he gets the article he requires. Trade thus leaves our shores, and having once done so, it does not return again, and those who were employed in the particular industry find that their occupation is gone, and that they must look elsewhere for work, which they may have great difficulty in finding. In fact, for insisting on having, say, 27s. a week when more than 25s. reduces the master's profit to practically nothing, the men, with wives and families to keep, find that their receipts often dwindle down to zero, while their hero and benefactor, Mr. John Burns, sits comfortably by his fireside devising further schemes of improvement for his fellow creatures! This, in a few words, is the whole gist of the matter.

Our contemporary, *Industries*, remarks that the Americans are, to some extent, exercised as to the probability of many English firms declining to exhibit extensively at Chicago, and there is, no doubt, the same likelihood of exhibitors in other European countries holding aloof. The question put by European firms is: Will exhibiting pay? To make it pay it must be useful as an advertisement, and extend sales in America or at home. It is questionable whether English manufacturers can sell goods in America to any extent. This arises, not so much from tariff difficulties, as from the difference in the methods of doing business. For example, most electric lighting in America is done by offshoots of a few large manufacturing companies, with "systems." In England one firm makes engines, another makes dynamos, and so on. There is certainly a tendency among American electric light companies to throw off the yokes of their parents, and to buy machinery in the open market, and this feature may help European manufacturers. In the open market, and with prejudice discounted, English electrical machinery could, we think, easily compete with American, but probably both might be beaten by the manufactures of Continental engineers. Under the present conditions of American electrical industry, it is scarcely likely that any European firms will exhibit heavy electrical machinery at Chicago.

But, says an American exchange:—"Passing over the fact that several of the most important of English and Continental electrical manufacturing concerns have already agreed to make displays at the World's Fair, in the face of our contemporary's objections, two curious misconceptions in the article quoted are at once apparent. For one thing, *Industries* totally fails to take into account any advertising results from the exposition save in the United States. Does it not realise that thousands of observing visitors from Canada, Mexico, and the Central and South American republics will carefully note the machinery, electrical and otherwise, at the exposition? Are English manufacturers prepared to abandon this field entirely to the United States, so far as the undeniably great influence of the World's Fair is concerned?"

"Then, again, our contemporary attaches an altogether fictitious importance to what it styles the 'system' method of doing business in the United States. Great electrical corporations, it is true, do exert a marked influence on the central stations of the country, but even these companies do not, with perhaps a single exception, make engines, as implied by the English paper. The statement that 'most electric lighting in America is done by offshoots of a few large manufacturing companies,' is inaccurate and misleading. In the largest arc lighting station in Chicago dynamos of half a dozen different manufacturers are employed, and even if it were not so, there would be nothing to prevent the purchase of English machines. The 'difference in the methods of doing business' should deter no foreigner from exhibiting at the World's Fair."

The Chicago Exhibition, which is now in course of preparation, will be visited by people from all parts of the world, and by many who are keenly alive to what they see around them. It behoves English manufacturers, therefore, to show that they are second to none in the quality and variety of their products, and this they must do by displaying their wares with a lavish and unsparing hand; for although they may not at the time cover their expenses, the outlay will be well repaid in the end if they can clearly show, as they certainly can, that their workshops can execute work unequalled in solidity and finish by any competitors. A defective exhibition of British industry, as the Attorney-General said in his address before the Society of Arts, must have the effect of losing for British trade, custom, and prestige; and, on the contrary, a fine display of English goods would attract custom not only to particular exhibiting firms, but to British industries generally. It is to be sincerely hoped, therefore, that those who are working hard to make the English section of the Exhibition a success will receive the very fullest support and encouragement, and not the least as regards the branch of industry which the ELECTRICAL REVIEW represents.

The Speed of Propagation of Electro-magnetic waves.

THE attempts made in order to determine experimentally the speed of propagation of electro-magnetic waves have not, up to the present, been very successful. Mons. R. Blondlot has, however, succeeded in effecting this determination by a new method, which is the subject of a memoir presented for him to the Paris Academy of Sciences, on November 9th, by Mons. Poincaré. An abstract of this memoir, accompanied by diagrams, appears in the *Comptes Rendus*, cxiii., No. 19, p. 629, which we may still further condense as follows:—Since, as MM. Sarasin and de la Rive have shown, it is the resonator that determines the length of the wave which is observed, the equation

$$\lambda = v\,T$$

ought to be satisfied if for λ and τ are substituted the values of the length of the wave and of the period peculiar to the resonator employed, and for v the speed of propagation of the wave. Thus the determination of the speed is dependent upon the determination of the period of the resonator and of the length of the wave which it defines. Giving to the resonator a particular form, Mons. Blondlot has been able to determine with accuracy the period of its oscillations; and in his memoir he describes the apparatus employed, with diagrams, and also the methods pursued in the observations. The results of 13 experiments, with the lengths of the waves varying from 8·94 m. to 35·36 m. per second, have led to the following conclusion, that the electrical undulations have only one speed of propagation which is independent of the length of the wave and about 297,600 kilometres per second. The number thus obtained from experiment is approximately equal to the ratio of the electro-magnetic and electrostatic units of electricity, as indicated by the theory of Maxwell, and also to the speed of light. It would be rash, however, to conclude from this equality, that the electro-magnetic vibrations are of the same nature; in fact, it is possible that the result obtained may not be found to favour this hypothesis.

The Theory of Parallel Wire Gratings.

IN our issue for April 17th, we dealt with a paper read by Sir William Thomson, before the Royal Institution, and which was entitled "On Electrostatic Screening by Gratings, Nets, or Perforated Sheets of Conducting Material." J. Clerk Maxwell in his theory of a grating with parallel wires, gave a valuable and interesting two-dimensional investigation of electrostatic screening, and a most instructive diagram of lines of force near a grating, which helps to understand and extend the theory and to acquit it of an accusation wrongly made against it in the last two sentences of Article 205, Maxwell's "Electricity and Magnetism." It was this difficulty which Sir William Thomson cleared up, and in his paper he treated the theory with some important developments. It appears that this work has just been noticed in *La Lumière Electrique* (November 7th, p. 285), in which paper it has attracted the attention of Mons. Haton de la Goupillière, a member of the Académie des Sciences, of Paris, and who more than thirty years ago worked upon the same theory. At the meeting of the Academy on November 9th, he called attention to the fact that he had dealt with the theory of a grating with parallel wires, as long ago as February 14th, 1859 [*vide Comptes Rendus*, Vol. xlviii.] His investigation, however, was undertaken from a different point of view to that of Maxwell or Sir William Thomson, and it led to demonstrating some remarkable properties of reciprocity existing between two potentials, relative the one to a grating in which all the wires are traversed by the current in the same sense, and the other to a grating traversed by the current in two opposite and alternate directions. Our readers might find it interesting to study the propositions enunciated by Mons. de la Goupillière along with the more recent work of Sir William Thomson.

Some Curious Electrolytic Observations.

WHEN a dilute solution of potassium acetate in water is electrolysed, only hydrogen and oxygen is evolved; but if the solution be a concentrated one, the gaseous product is a mixture of ethane, hydrogen, oxygen, methyl acetate (trace) and carbon dioxide; a portion of the carbon dioxide arising from oxidation of some part of the electrolyte or product of electrolysis. Dr. T. S. Murray has recently been investigating the influence of concentration of solution, strength of current, size of electrodes, temperature, &c., on the course of the electrolysis. On diluting the solution of acetate, the amount of ethane produced decreases, at first very slowly, but, finally, with great rapidity. Reducing the current has a similar influence. With rise of temperature the ethane diminishes in quantity more rapidly the higher the temperature, and ceases to be formed at about 100° C. The employment of a large anode reduces the yield of ethane; the largest yield being obtained by the use of a very small anode; variations in the cathode do not influence the electrolysis. The presence of acetic acid, or of alkali, even in small quantity, reduces the yield of ethane. The oxidation of the electrolyte to carbon dioxide, which proceeds simultaneously with the formation of ethane, is affected very differently by changes in the several conditions. Thus, for a given yield of ethane = 25, say, the corresponding oxidations produced are, by change of current, 96; by varying size of anode, 68; by varying concentration, 60; by varying the temperature, 50; possible oxidation being taken as 100. This investigation, when published in detail, will be illustrated by a series of curves. Dr. Murray believes that he has demonstrated that the ethane is formed, not by the partial oxidation of the acetic acid, as Burgoin, Jahn, and Bunge believe, but that it results from a simple interaction of the "acet" ions ($CH_3 \cdot COO$).

Electricity in Mining Work.

MR. SYDNEY F. WALKER presented to the American Institute of Electrical Engineers some months ago a paper, which purported to describe the use of electricity in English mines. This paper has been published in the Proceedings of the Society, but in the printed discussion the author's statements are somewhat roughly handled by American engineers. Mr. Hollon C. Spaulding, in his communicated remarks, says that the makeshift methods described by Mr. Walker are not of the ultra-conservative ways which have been held up to Americans as types of English practice. Mr. H. Ward Leonard, a little less merciful in his criticisms, expresses surprise at the methods which Mr. Walker describes as being used in English mines. One of Mr. Walker's statements says the writer indicates a lack of knowledge of the necessary conditions for success, which is difficult to conceive. Proceeding, Mr. Leonard says that the quality of the mine fuses used in England appears to be inexcusably bad. We give the following sentences of the critic in full:—"Mr. Walker states that he found it impossible, in his experience, to properly operate two dynamos in multiple arc with each other. He states that, 'while the dynamos are supposed to furnish the same E.M.F. between their terminals, in practice they never do.' Apparently Mr. Walker is totally unfamiliar with the methods which are in use throughout the world for equalising the E.M.F. and consequent current of dynamos in multiple arc. It would probably surprise Mr. Walker greatly to see what is common practice with the Edison company in this country, viz., the operation of as many as 20 different dynamos, frequently of different sizes, all operating in multiple arc and dividing the current exactly in proportion to their sizes. If we can judge from Mr. Walker's paper, it is common practice in the mines in England to use the old wire rope for electric conductors. That any such conductors should be used in a mine is only less surprising than that a party, whom he states studied the matter very carefully, proceeded to insulate the old wire rope by 'a mixture of coal dust and pitch.' Mr. Walker states that the gentleman who originated this novel insulation met with entire success; but I am not surprised at the further statement that 'others who have followed him have not always been so fortunate.' It seems hardly possible that Mr. Walker in his paper has described a practice in electrical engineering which is common in England; and yet one cannot avoid the inference that he himself believes so. In view of the publications in the American journals—some of which have been copied in the English journals—regarding the character of mine installations in America, it seems entirely unnecessary to make any comparison between the character of the work done here (America) and the kind of work which is described by Mr. Walker."

COMMUNICATIONS FROM AUSTRIA-HUNGARY.

[FROM OUR OWN CORRESPONDENT.]

THE erection of electrical works for lighting towns has latterly made satisfactory progress in Austria-Hungary. In Hungary, at present, only two towns possess such works, but Szathmar, Nagybánya, Erlau, Nyiregyháza and Klausenburg are preparing to introduce the electric light. In the first-named city the works are already in hand. The installation is being carried out by Siemens and Halske, who employ there the "three-lead" system with accumulators. The central station is erected at a distance of about one kilometre from the centre of the city, whence the current will be conveyed in aerial leads, without coatings, to the theatre, where the battery of accumulators is set up. From here the distributive leads branch off to the different parts of the city, and the entire illumination, private and public, will be supplied by the accumulators above mentioned.

The entire installation is arranged in the first place for 1,000 lamps of 16 normal candles each, and 10 arc lamps, and the completion of the whole, as the first municipal lighting with accumulators, is awaited with a lively interest.

In Bielitz and Biala, two small industrial towns in Austrian Silesia, situate in close proximity, the International Electric Company, of Vienna, has obtained a concession for electric works, and has already commenced operations. The installation will be supplied with alternating current transformers, and it will supply electric energy not only for lighting, but as motive power for the extended small industries of the two towns. At Bielitz and Biala there exist also gasworks, and electricity will, consequently, here have to encounter the rivalry of gas.

The municipal council of Sarajevo, the seat of the Bosnian local government in its last session, voted a subsidy of 360,000 florins for the erection of an electrical works, which the city will build and conduct on its own account.

This project, laudable in itself, seems to have a somewhat fantastic basis, since it is intended to use as the motive power an available and copious water power of the Zayce, which would certainly be highly suitable for such a purpose, but has the serious disadvantage of being at the distance of 180 kilometres from Sarajevo. For this very interesting project the town seems to have anticipated the hopes which the friends of the Lauffen-Frankfort experiment have built upon its industrial success. We will hope, however, that the project of the town of Sarajevo, which has the active support of the government of Austria-Hungary, will take a more practical shape and meet with success.

The annual report, just published, of the Royal Hungarian Ministry of Commerce, mentions, among the measures taken in 1890 in the interest of the development of telephones and telegraphs, the Budapest-Vienna State telephone, and pronounces it one of the most important advances in telephony.

From this voluminous report we reproduce the following passages :—

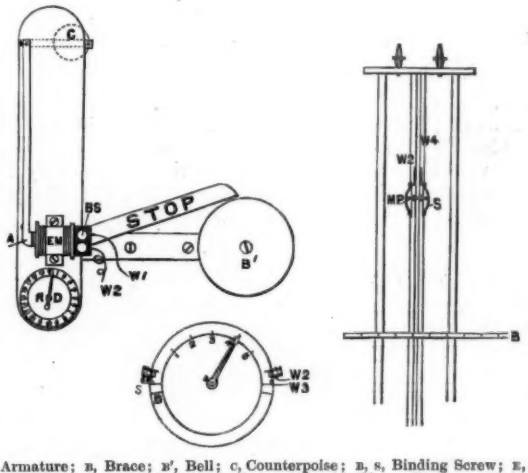
Whilst in the erection of short local telephones it is possible to proceed according to methods which have already been found satisfactory, no sufficient experience for long lines was on record. The inter-urban telephonic connections, Paris-Brussels, Hamburg-Berlin, &c., employ systems differing from each other and from that of the Buda-Vienna line. A novel method had to be attempted which would combine economy with certainty of action. This was effected by placing three leads upon one series of pillars (instead of two as heretofore), and placing the connection along the railway, parallel with the telegraph. The disturbances by induction which have hitherto been prevented by costly coatings (Paris-Brussels, Van Rysselberg system), are here eliminated by having the telephone leads twisted. The control maintenance is much more economical than when the telephone wires are carried along the roads. This innovation was perfectly successful. Two leads are used for speaking and act faultlessly, whilst the third is in reserve in case of accidents. There were 52,620 conversations transmitted; 27,718 sent from Budapest and 24,902 from Vienna, almost the half of which related to stock exchange matters, For the sake of cheap fees and punctual service, the Minister of Commerce resolved that in the larger towns the telephones should be erected and worked by the State. Fiume and Oedenburg have been supplied in this manner; operations have been commenced at Raab, and the telephone at Arad has been redeemed by the State. All these telephones have been constructed and maintained by the staff of the Department of Posts and Telegraphs. Between Kesmark and Liebitz and between Klausenburg and Gyalu telephonic connections have been arranged supplementary to the telegraphic net.

On the telephones 6·94 millions of conversations have been exchanged. Of these there were on the municipal lines 6·884 millions, and on the inter-urban 2,419. The municipal telephones have the length of 3,854·3 kilometres (Budapest, 2,941·787; Temesvar, 220·978; Delreczin, 130·785; Grosswardein, 114·7; Agram, 99·36; Pressburg, 94·383; Fünfkirchen, 68·481; Szegedin, 49·405; Arad, 48·46; Oedenburg, 46; Miskolcz, 40). The number of subscribers is 2,178, of whom 1,380 are in Budapest.

The telegraphic net is 21,121 kilometres in length (against 19,892 in the previous year). Of these 18,889 kilometres are State telegraphs, 2126·3 railway telegraphs, 106·3 private telegraphs; the length of wire is 75,601·5 kilometres. 7·6 million telegrams were dispatched (2½ millions inland, 3·4 millions in transit, 0·7 to foreign parts, 0·8 from foreign parts). From Hungary were dispatched 3·2 million telegrams; to Hungarian stations 2½ millions, to Austria 0·57, to Germany 0·09, to Roumania 0·025, and to Servia 0·022.

AN ELECTRIC INDICATOR AND OVER-WINDING ALARM FOR MINES.

OUR illustrations, figs. 1, 2 and 3, represent an electric indicator and over-winding alarm for use in mines, which will notify the approach of the cage in the shaft to the surface, and also prevent over-winding. It is made by Messrs. Thompson & Co., engineers, Castlemaine, Victoria, Australia. The indicator is worked by a worm wheel on the end of the drum shaft, moving a finger round a circular plate (fig. 1) in front of the engine attendant. On the rim of the plate are the marks for the different levels of the



A, Armature; B, Brace; B', Bell; C, Counterpoise; E, S, Binding Screw; E, Electro-magnet; R, D, Recording Dial; M, P, Movable Pin; S, Spring; S, Surface; w^1, Wire to brace; w^2, Wire to battery; w^3, Wire to bell; w^4, Wire to alarum.

FIG. 1. FIG. 2. FIG. 3.

mines as well as two contact pieces (fig. 2) actuated by the point of the finger. As the cage approaches the surface the finger completes the circuit, ringing an electric bell placed in a suitable position in the engine house to attract the attention of the attendant. As the cage descends, the finger lifts a spring, and thus avoids making contact, as it passes a contact piece, and as a result the bell is not rung until the opposite cage approaches the surface. The contact pieces are clamped on the plate by a set screw, and in the event of the length of rope being altered on the winding drums, the alteration of the position of the contact piece corresponding to that rope can be made in a quarter of a minute.

The over-winding alarm (fig. 3) is worked from the same battery as the indicator, but it is quite independent of the latter, being actuated by the cages themselves. Above the landing place, at a certain point beyond which it is desirable that cages should not be raised, are fixed on the centre sked two springs, as shown, the compression of either of which by a rising cage completes the circuit with the other and causes a semaphore arm in the engine house to drop, and at the same time rings a bell, which continues ringing until the arm is replaced by the engine attendant. At the bottom of the semaphore is a dial with an index finger, and every time the arm fal's the finger advances one point, thus not only warning the attendant that he is over-winding, but a record is made that such has been done. The majority of over-winding accidents occur through the starting of the engine the wrong way. With this device, however, the attendant would be notified of the fact before he had thrown his engine into gear, and so have a chance of reversing before any accident occurred. The apparatus appears to be simple in construction and not liable to get out of order.

PRELIMINARY NOTE ON A METHOD FOR DETERMINING THE PERIODIC CURVES OF ALTERNATING CURRENTS.*

By Dr. LOUIS DUNCAN.

THE experimental methods heretofore used for the determination of current and electromotive force curves in alternating circuits present many difficulties, and are cumbersome and tiresome. Most of those now in use are based on the experiments of Joubert, who obtained the E.M.F. curve of a De Meritens dynamo by making instantaneous contacts between the dynamo circuit and measuring circuit at different points on the E.M.F. curve. This method was modified by Messrs. Wilkes, Hutchinson and myself to give curves of primary and secondary E.M.F. and current in alternating circuits containing transformers, condensers, &c. Our method has been copied by Prof. Ryan and others, and the results which we obtained some years ago have been duplicated and extended. M. Blondlot has recently still further modified the method by using a galvanometer, through which a condenser charged to a potential representing different points on E.M.F. curves is discharged, the deflections being photographed. By using two contact making arrangements or wipers,† with two galvanometers, two curves were obtained at the same time.

The difficulties of most of these methods lie in the very considerable potentials used on the commutators—as much as 1,500 volts in some experiments—and the fact that only one curve can be obtained from each commutator, with the possibility of error due to the contacts.

The following method is simpler, and gives better results. To get the four curves representing the primary and secondary E.M.Fs. and currents, four small dynamometers are made, and their stationary coils wound for primary current, primary E.M.F., secondary current and secondary E.M.F. respectively, their movable coils being connected in series, in circuit with a few storage or other cells; this latter circuit having one end connected with the contact point on the dynamo shaft, the other end connected to a wiper touching the contact point at each revolution. The wiper is movable through the arc of a circle (180° is sufficient, unless the curves are to be photographed). These dynamometers may be cheaply and quickly made with wooden spools and a quartz fibre suspension, the current being carried by pieces of coiled tinsel or fine wire, as in a D'Arsonval galvanometer. Four of them may be easily made in a day.

In making the experiments the deflections of the dynamometers are either observed or photographed. It is evident that if the instantaneous current in a movable coil occurs when the curremt in the stationary coil is zero, there will be no deflection; if the latter current is at its maximum, the deflection will be a maximum; while for intermediate values the deflection (I am considering small deflections, of course,) will be proportional to the instantaneous value of the current in the stationary coil. By moving the wiper through 180° uniformly, if we are photographing, we get all of our curves simultaneously, with no possibility of changed conditions changing their relative values. A galvanometer in circuit, with the movable coils, allows an absolute scale to be applied to the curves, after the dynamometers have been once calibrated, and eliminates any error caused by the wiper. We are thus able to obtain any number of curves simultaneously with only one commutator, with only a few volts on this commutator, and with no possibility of errors due to the wiper speed.

* New York *Electrical World*.

† Is this an American expression for the German Wippe?—EDS. ELEC. REV.

RECENT RESEARCHES ON MAGNETIC ROTATORY POWER.

OUR present knowledge of the relation between the magnetic rotation of chemical compounds and their composition and constitution, is due almost solely to Dr. W. H. Perkin, F.R.S., who by his searching investigations has made it possible to establish general relations in this branch of science. One of the general results of this work is the conclusion that the magnetic rotation is an additive property, that is, that the magnetic rotation of a compound is the sum of the magnetic rotations of its components.

In the early part of this year Ostwald published a paper in which he argued that although the magnetic rotation is in the first instance an additive property, it is subject to an influence of a "constitutive" character, or differences of constitution. (We noticed this paper in our issue for February 20th, p. 234).

The fundamental difference existing between electrolytes and non-electrolytes has, as is well-known, been explained by Arrhenius on the theory of electrolytic dissociation. Ostwald is an ardent supporter of this theory and he argued, in the paper to which we have alluded, that the facts observed by Dr. Perkin are in full accordance with this much debated theory and quite inexplicable by the older views. For example he stated the opinion that the peculiar variations in the magnetic rotation which Dr. Perkin has observed in the case of solutions of acids, of ammonium salts, &c., are in accordance with this hypothesis.

Ostwald has suggested that since salts formed from weak acids are as good conductors of electricity as those formed from strong ones, deviations from the calculated values must be expected; and in his work on solutions this scientist states his opinion that there is no doubt that such salts as ammonium formate, when in aqueous solution, would show molecular rotations which would not be the sums of the rotations of the components of the salts as must (nearly) be the case if the view put forward by Dr. Perkin be correct, that such salts are almost entirely dissociated into acid and base.

Recently, Dr. Perkin has been carrying on an investigation with a view to throwing further light upon this subject, and at a meeting of the Chemical Society, held on November 5th, the results obtained were presented, and will appear in due course in the *Transactions*.

Here are some results which were obtained.

Substance.	Mols. water to 1 mol. salt.	Mol. rot.	Average mol. rot.
Ammonium formate	3·00	3·363	—
" "	8·78	3·394	—
" "	10·00	3·333	3·363
" acetate	4·75	4·246	—
" "	13·13	4·247	4·246
" propionate	2·86	5·255	—
" "	10·26	5·263	5·259
Sodium formate	5·40	2·364	—
" "	12·54	2·331	2·347
" acetate	11·23	3·281	3·281
" propionate	7·00	4·308	4·308
" butyrate	6·81	5·332	5·332

On examining these figures it will be seen that the rotatory powers of the ammonium salts do not vary with dilution;

there can be little doubt that this is true, also, of the sodium salts, as sodium formate shows no difference on dilution. Comparing the experimental values obtained in the case of the ammonium salts with those afforded by the constituent acid and ammonia, the following results are obtained :—

$C H_2 O_2$	... 1·671	...	$C_2 H_4 O_2$	... 2·525	...	$C_3 H_6 O_2$	... 3·462
$N H_3$	... 1·818	...		... 1·818	...		... 1·818
	3·489			4·343			5·280
Amm. salt	3·363			4·246			5·259
Diff.	... 0·126			0·095			0·021

As might be expected, since reduction of rotatory power always attends combination, the values are slightly less in the case of the salts.

Dr. Perkin pointed out that the reduction is very nearly the same as that which takes place in the formation of the corresponding ethereal salts, and as these latter salts are anhydrous, the results may be held to justify the conclusion that the values obtained for ammonium salts in solution are practically those of the dry salts, and, therefore, that Ostwald's views are inapplicable. In the case of the sodium salts it is very difficult to arrive at a conclusion, as the value of the sodium is unknown ; but Dr. Perkin showed that whatever influence water has on them, must be supposed to act to the same extent on all the four salts examined.

separated from each other by paper, and the whole is supported by a strong cast-iron centrepiece, keyed to the engine crank shaft. The commutator has 347 segments, insulated with mica, and the ring carrying it is secured to the armature casting above mentioned. In connection with the commutator, it should be mentioned that this machine is quite exceptional in having mica between the segments, the insulation used almost universally for German machines being of "presspahn," or cardboard made from wood pulp. The radial magnets are cast in one with the octagonal frame which supports them, the latter being jointed vertically, as shown. Two sets of brushes, at 45 degrees angular distance apart, collect the current which flows through the 694 conductors in two parallels. The engine cylinders are 32·5 cm. and 50 cm. diameter, respectively, and the stroke is 60 cm. The working pressure is 8 atmospheres, and the steam is admitted by double-beat valves in conjunction with trip gear, the point of cut-off being controlled by the governor. The combination exhibited gives for each kilogramme of steam a return of 71 watt-hours with, and 52 watt-hours without, a condenser, the exhibitors stating that their object has been not to get a dynamo which does a large quantity of work for its weight, but one from which is obtained the highest electrical return for the consumption of a given quantity of fuel.

The machine above described is shunt wound, and supplies current through a five-way system of distribution.

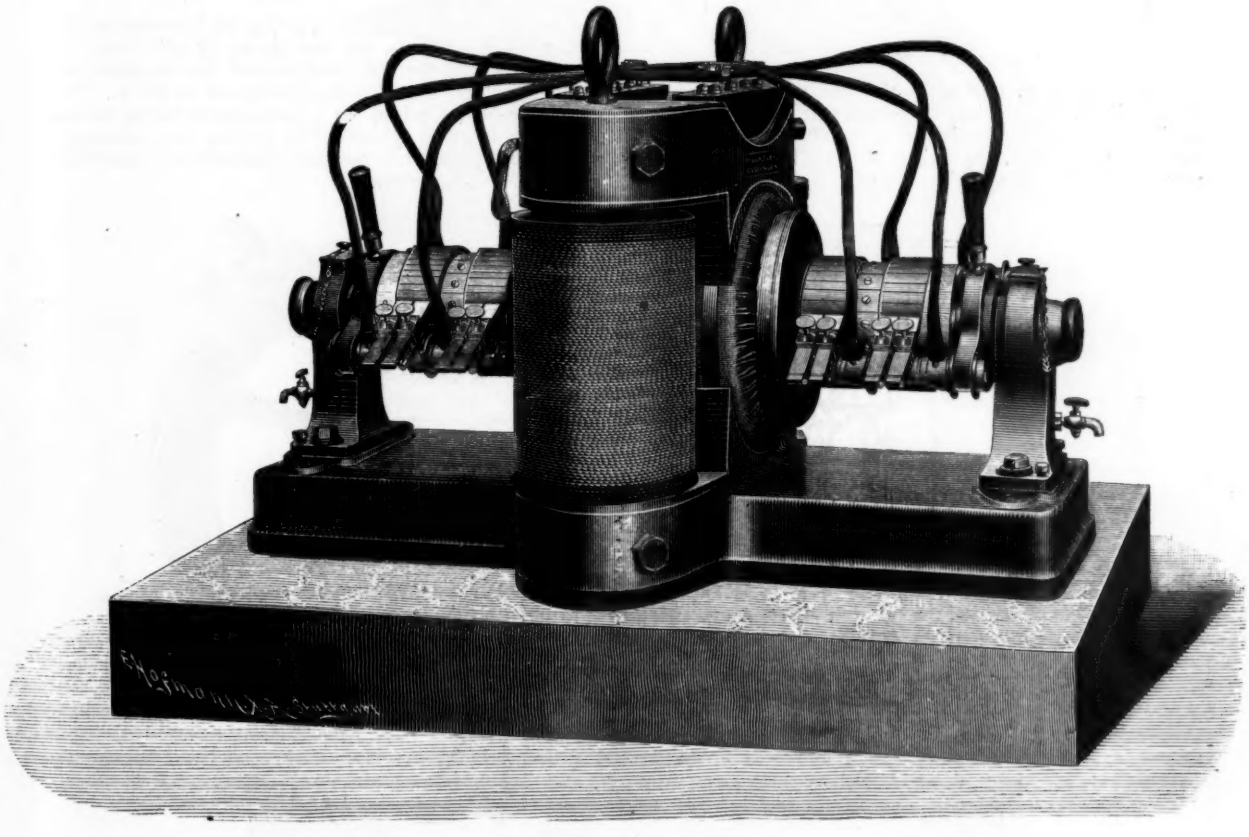


FIG. 35.

THE DYNAMOS AT FRANKFORT EXHIBITION.

BY W. B. ESSON.

VII.

The Maschinenfabrik, Esslingen, exhibited the eight-pole 60 kilowatt dynamo, shown in fig. 34. This machine is coupled direct to a horizontal compound engine, and gives, at a speed of 100 revolutions per minute, a current of 124 ampères, at a difference of potential of 480 volts. The armature is 114 cm. in diameter, and has a drum winding, there being 694 conductors on its exterior, counted all round the periphery. The armature core is built up of iron plates, 1 mm. thick,

The two outside conductors of the system are connected to the machine terminals, while the three intermediate conductors are connected up to a compensating motor-dynamo. This compensator consists of the machine illustrated in fig. 35, which has an armature Gramme wound, with four distinct circuits connected up to four separate commutators. The magnet winding is a shunt to the two outside wires and the excitation is consequently constant, due to a potential of 480 volts. It will be seen from the diagram of connections, fig. 36, that all the commutators are joined in series, the first and fifth conductors being connected outside the two extreme ones, and the second, third and fourth between consecutive ones. When all the four circuits take through R_1, R_2, R_3, and R_4, the same current, the motor-dynamo is driven by

a small current flowing through the four armature windings, A, B, C, and D, in the same direction. If in one of the branches, say R_2, the resistance is increased, the difference of potential between the two conductors 2 and 3 rises by a very small amount, while in the other three branches it falls.

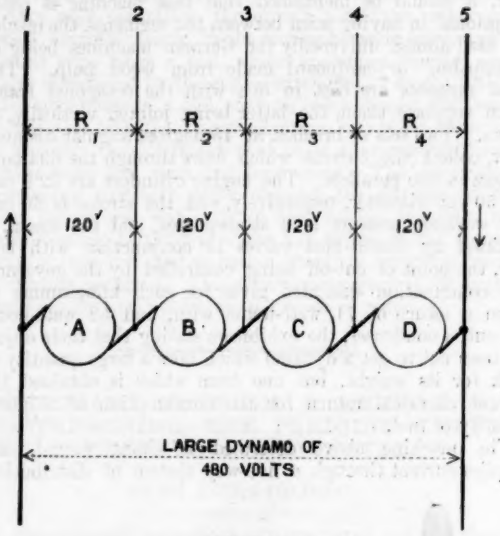


FIG. 36.

The consequence is, that while the armature increases in speed a little, the winding, B, between the wires, 2 and 3, receiving current and acting as a motor, the other three windings A, C, and D, are acting as generators, the current now flowing in an opposite direction through them and an E.M.F. being added to the circuits, R_1, R_3, and R_4, with which they are connected. The compensator in this way keeps the difference of potential for each circuit constant always running as a motor and taking power from the least loaded circuits to give it back, acting as a generator, and raising the potential of the circuits loaded more heavily. The writer is assured that the compensator acted most efficiently, the four voltmeters in the branches showing no perceptible deviation from 120 volts.

Current may be taken direct from the terminals of the machine at 480 volts, or, if desired, from the middle wire and one outside one at 240 volts. At the former pressure it was supplied to the 50 H.P. four-pole motor used to pump the water from the Maine quay to the lake in the Exhibition grounds, and for this purpose the dynamo had to run nearly all day, as the water was used for condensation in several steam engines. The other electromotors coupled to the system were supplied with current at 120 volts, as were also all the arc and glow lamp circuits.

Messrs. Pokorny and Wittekind, of Bockenheim, exhibited the four-pole 15 kilowatt machine shown in section in fig. 37. This machine is direct coupled, and running at a speed of 400 revolutions per minute it gives 246 ampères at 65 volts pressure. The armature core is constructed of thin iron plates, insulated from each other in the usual way, and having two stronger rings on the outside to clamp the whole together and give it the necessary stability. The armature winding is of copper bars with papier-mache between the adjacent convolutions, and the joints are dovetailed and soldered. In the greater part of the winding the current density does not exceed 1 ampère per square millimètre, though at the smallest part of the cross section it rises to about 4 ampères. The armature is supported by insulated through bolts, secured to the starwheel, as shown, and the current is collected by four sets of three brushes, which can be put down or lifted simultaneously by a lever. The four radial magnets with their pole shoes are of wrought iron, the central yoke piece being a casting which is bolted to the engine frame. The engine cylinder is 20 cm. in diameter, and the piston has a stroke of 20 cm., the working pressure being 8 atmospheres.

A two-pole overtype machine, giving 33 kilowatts at 600 revolutions per minute, was also shown by this firm. It was drum wound for 300 ampères, and the armature core had longitudinal slots for the conductors to lie in. The sections were coupled up to a commutator having 50 segments, the magnets, cylindrical in section, were cast in one with the bed plate, while the shaft journals were fitted each with three self-oiling rings.

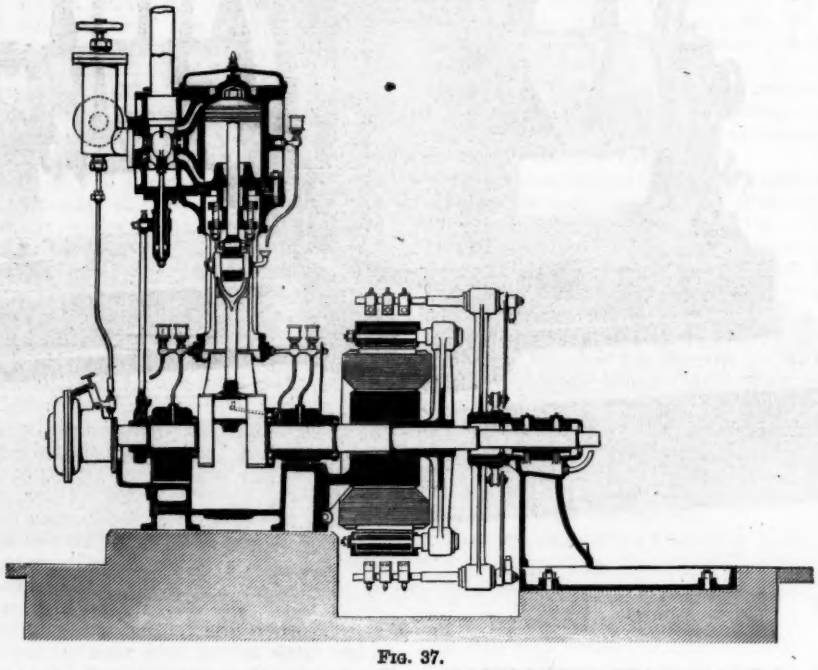


FIG. 37.

Messrs. Naglo Brothers, of Berlin, exhibited an interior pole machine, giving 32 kilowatts at a speed of 200 revolutions per minute. This machine had four poles, and the armature was supported from the star wheel by sixteen bronze bolts insulated with paper. The current was collected from the periphery of the armature as in the interior pole machine last described. There were four sets of three brushes, and the conductor bars serving as commutator were separated by cardboard insulation. The machine was directly coupled to a vertical engine, which, from a flywheel on the opposite end of its crank-shaft, also drove by belt a 40-kilowatt two-pole dynamo.

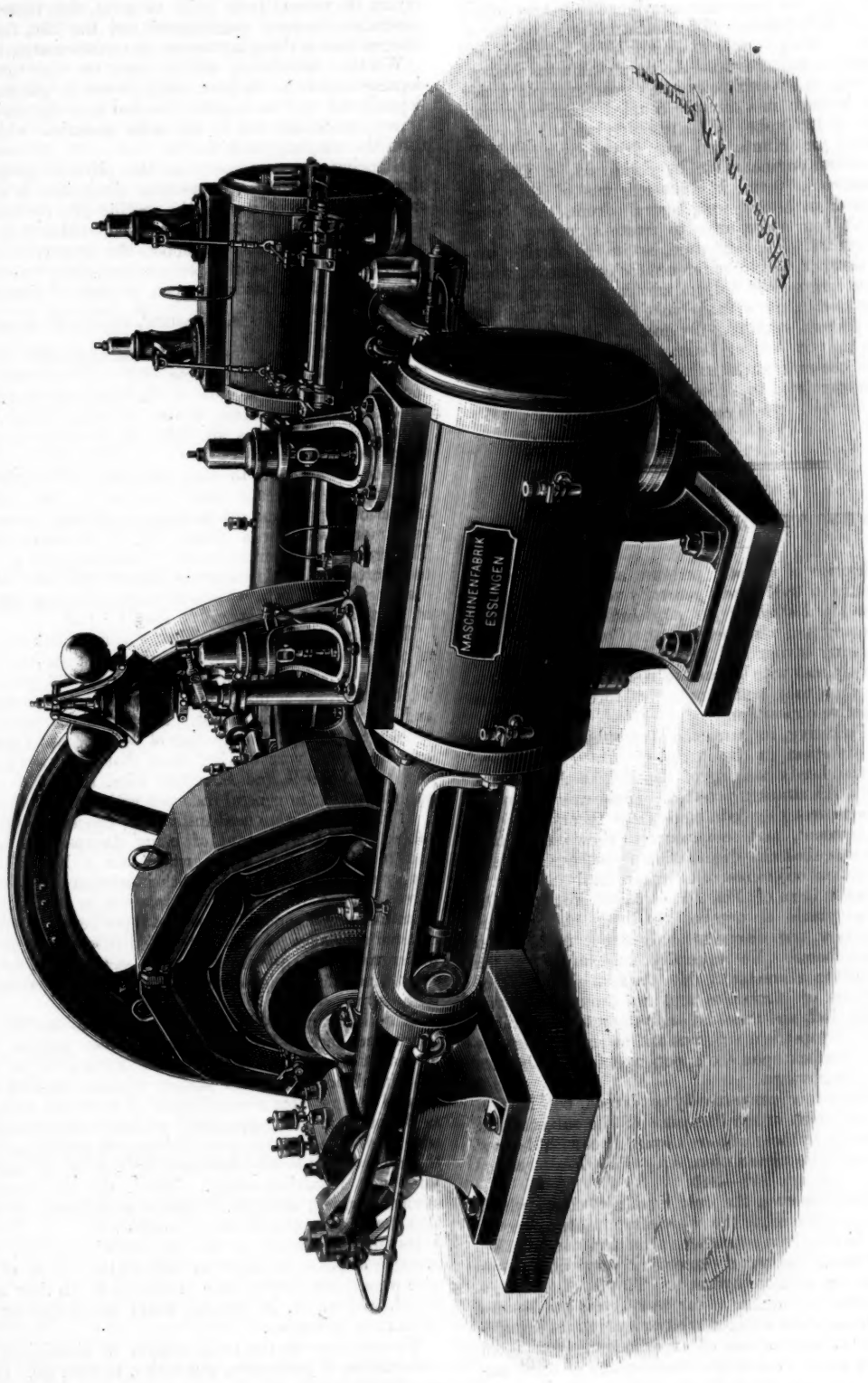


Fig. 34.—The Maschinenfabrik 8 Pole 60 Kilowatt Dynamo at Frankfort Exhibition.

Messrs. Einstein & Co., of München, exhibited several two-pole and four-pole machines. The former are of the overtype pattern, the two magnet limbs being cast in one with the bedplate, and the armature cores provided with grooves on the exterior, in which to lay the conductors wound Gramme fashion. Machines above 10 kilowatts are made four-pole, the radial magnets being cast in one with a circular yoke ring, the latter also carrying the feet by which the machine is bolted down. The armature is supported at each end by a bridge bracket diametrically spanning the yoke ring and bolted thereto. Above 30 kilowatts Messrs. Einstein's dynamos have six poles, and a good example of this class was to be seen in a directly coupled machine, giving 75 kilowatts at 120 volts. This machine ran at a speed of 200 revolutions per minute, and was driven by a 125 H.P. compound vertical engine made by Swiderski, of Leipzig. The armature core, 70 cm. in diameter, was of thin iron plates, mounted on a cast iron central drum, this being furnished with four skew arms to create a current of air through its centre. The armature, as in the smaller machines, had slots on its circumference for conductors, which were this time arranged in a drum winding. The six radial magnets were cast in one with the yoke casing, and had slots in them to prevent heating. By means of a simple lever arrangement the six sets of brushes could be put down or lifted off the commutator, simultaneously, or their pressure on the surface regulated to a nicety.

(To be continued.)

THE NEW THEORIES OF SOLUTION.

SINCE the theories of osmotic pressure and of electrolytic dissociation were in 1887 made generally accessible by their publication in the *Zeitschrift für physikalische chemie*, they have in Germany and elsewhere on the Continent enjoyed an ever increasing favour and popularity. In this country they have mostly met with a passive resistance; but in one or two cases, where they conflict with rival theories, they have encountered active opposition.

Mr. S. U. Pickering, in particular, has subjected them to unfavourable criticism in the pages of *The Philosophical Magazine*, at the Leeds meeting of the British Association, and elsewhere. His attack is two-fold. In the case of osmotic pressure, he compares the deductions from theory with the results of experiment, and endeavours to show discordance between them: against the dissociation hypothesis he seeks to raise "theoretical objections of a fundamental character."

In the October issue of *The Philosophical Magazine*, Dr. James Walker passes a number of these unfavourable criticisms in review, and discusses the grounds upon which they have been based. He especially concerns himself in examining into the character of Mr. Pickering's objections to the hypothesis of Arrhenius and the osmotic pressure theory of Van't Hoff, and these he analyses rather severely; in fact, the whole paper is a vigorous and at times somewhat pungent counter-attack upon the opponents of these theories or rather upon their views.

The paper cannot be conveniently condensed, but it is an important contribution to the literature of the subject, and should not be missed by those who are keeping pace with the new theories of electrolytic dissociation, &c. *Vide Philosophical Magazine* (5), xxxii., pp. 355—365.

As Dr. Walker observes, the only rival hypothesis which has been actively pursued, is the "hydrate" theory, according to which the dissolved substance in an aqueous solution is combined with all the water (except in very dilute solutions) to form one or more hydrates. This is, of course, a perfectly legitimate hypothesis as far as it goes; but besides suffering at present from a slight arbitrariness in its employment when the interpretation of experimental data is in question, it also labours under the disadvantage of being unable at present to afford any secure basis for calculation.

Whatever of future development may await the hydrate theory, Dr. Walker is of opinion that it cannot be looked upon as a serious rival to the hypotheses of osmotic pressure and electrolytic dissociation, the list of whose achievements is constantly increasing.

ALUMINIUM v. COPPER.*

BY A. SAUNDERS MORRIS.

ELECTRICAL conductors may be divided into two general classes, those used in the strictest sense of the word for conveying the current from point to point, and those used on generators, motors, transformers and the like, forming an integral part of the apparatus for the transformation of energy.

Whether aluminium will be used for the former class depends largely on its price, while its use in generators, &c., depends not only on its price, but also upon the design of the apparatus and the cost of the other materials which go to form the complete machine.

Glancing for a moment at the physical properties of aluminium and copper, we see that aluminium is about one-third the weight of copper, the specific gravity being 2·67, and that of copper 8·89. The specific resistance is, however, almost twice as great as copper, the proportion being as 1 : 1·845. The weight for an equivalent resistance will therefore be ·555 that of copper, or cost of aluminium = $\frac{\text{cost of copper}}{\cdot 555}$. This is, of course, equivalent to saying that if the cost of copper wire is 15 cents, aluminium wire must be sold for 27 cents to compete with it for electric conductors. As the cross section of an aluminium conductor, to have the same resistance as one of copper, must be 1·845 as great, these figures are only correct where uninsulated wires are used.

Since the areas are to each other as 1 : 1·845, the circumferences will be to each other about as 1 : 1·36. Hence the insulation for an aluminium wire should weigh about 36 per cent. more than for a copper wire of the same resistance. The practice of manufacturers of insulated wire is, however, to increase the thickness of insulation with the increase in diameter of the wire, which, of course, increases the weight of insulation at a greater ratio than 1 : 1·36.

The average saving in weight by using aluminium in place of copper for insulated wire, as estimated from the tables of a well known manufacturing company, is 33 per cent. for the lowest grade of insulation, 22 per cent. for the next grade and 18 per cent. for the best. Another make shows a saving of 26 per cent. and still another of 24 per cent. These figures are for sizes of wire varying from that equivalent in resistance to a No. 0 B. and S. copper wire, to No. 9 inclusive, and the saving in general increases with the size of the wire.

If aluminium were used instead of copper in lead covered cables, the weight, instead of being decreased, is increased, and in the example taken, which was a No. 2 B. and S. copper conductor with one-eighth insulation and a lead cover three thirty-seconds thick, the increase in weight by using aluminium was something over 43 per cent. As most lead covered cables for electric light and power work are for use underground, the question of cross section is of far greater importance than weight, and hence there is nothing better than copper.

The disadvantages in the use of aluminium for electric conductors are:—First, increased cross section and its attendant circumstances, increased surface to be covered with insulation, increased surface exposed to wind and increased danger from accumulations of snow and sleet, as well as the objectionable appearance of larger wires than at present used. Second, the great difficulty of soldering, although this objection is largely decreased by the use of mechanical joints not requiring solder. Third, the decreased tensile strength, which, however, is partly neutralised by the fact that the cross section is nearly doubled.

Its sole advantage is the decrease in weight, but the strength of poles is ample to support the weight of copper wire were it not for the side strains to which they are subjected, and which, in general, would be greater for aluminium than for copper.

We now come to the consideration of aluminium in the construction of converters, generators, motors, &c. Taking a well-known make of converters in which the iron core surrounds the copper wire as an example, and replacing the copper with aluminium having the same resistance and number of turns, the insulation being the same, we see that

* New York *Electrical World*.

the area of the openings in the iron core must be increased about 31 per cent., and preserving the same cross section of iron magnetised its weight has been increased 11 per cent. But the weight of conductor is about half as great for aluminium as for copper, and this decrease just about balances the increased weight of iron. The actual saving in weight is about two per cent., but the volume is increased, say, 11 per cent., and consequently the weight of the containing case would have to be increased, which would really make the converter wound with aluminium somewhat heavier than one wound with copper, and its efficiency would probably be a trifle lower, although its ohmic resistance is the same.

If aluminium were used instead of copper in a direct current generator, the armature, to have the same ohmic resistance and the same air gap, would have to be considerably larger. This would in turn require larger fields, and these would have to be somewhat increased in general dimensions to accommodate the increased section of wire, so that in all probability what would be saved in weight by using aluminium would be lost on account of the greater weight of iron necessary for structural reasons. Indeed it would be difficult to use aluminium without changing the design materially and probably sacrificing efficiency. The inability to use solder becomes a far more serious difficulty in machine construction than in line work.

From the facts it would seem that, however great the usefulness of aluminium in general, its substitution for copper in the field of electricity is limited, even if its present price were materially reduced.

CERTAIN POINTS OF ANALOGY BETWEEN DYNAMOS AND TURBO-MACHINES.

IN the Department of Applied Mechanics of the Paris Academy of Science, a note was read from Mons. Rateau at the meeting on November 9th, entitled, "The Theory of Turbo-Machines," in which he pointed out the existence of certain analogies which exist between turbo-machines with intermittent currents and dynamos with alternating currents.

Let Q represent the output of a turbo-machine, and H the difference between the charges which exist in the two *enceintes* between which it is interposed; the function $\frac{Q}{3\sqrt{H}}$, which is identical in certain particular cases with that which Mons. Murgue has styled the "equivalent orifice," is very interesting to consider. It is analogous to *conductivity* in electricity, and is termed by Mons. Rateau the *ouverture* (aperture); its square root is the side of the *ouverture*.

In the case of a generating machine, the function $\frac{H}{Q^2}$, which is strictly related to the preceding, is called the resistance of the external circuit; and, for any turbo-machine whatever, the function $\frac{H'}{Q^2}$ represents the internal re-resistance, H′ being the loss of charge in the interior of the apparatus.

A type of turbo-machine having been determined, the dimensions of the apparatus, which ought to be taken in each case in order to determine the best efficiency, are proportional to the side of the *ouverture*, which corresponds to the output and to the difference of charge demanded.

This theorem is very important in practice, for it indicates with precision how the apparatus should be selected for the applications which are proposed.

A consideration of the analogies which exist between dynamos and turbo-machines is very fruitful in deductions. Here is a brief *résumé*:—

The two kinds of apparatus have for their object the circulation of a gas, steam or liquid, or of electricity. This result is obtained by the rotation of a turbine or of a coil of which the speed should increase with the difference of tensions, for in the case of either machine a difference of tension has to be dealt with.

Besides the movable turbine or coil, as the case may be, each apparatus comprises also two other important parts, namely, in the one a distributor or collector which may be simple or multiple, and in the other an inductor, or whatever else it may be termed, which may be simple or compound.

The total electromotive force developed by a dynamo is proportional to the number of lines of force cut by the coils of the armature. Similarly the fluidomotive force (difference of tensions) created by a turbo-machine, is proportional to the number of certain lines cut by the blades of the turbine. These lines are the orthogonal trajectories of the absolute trajectories of the fluid.

In both kinds of apparatus the motive force is employed to overcome resistances both internal and external; of these the former results in a transformation of mechanical work into heat.

The characteristic curves worked out with regard to the function of the *ouverture* or of the conductivity of the external circuit exhibit great similarity.

In dynamos where the external resistance varies, in order to obtain the best efficiency, the method adopted is directly comparable to that which is necessary in the case of a turbo-machine when the *ouverture* varies.

Mons. Rateau's original paper may be consulted in the *Comptes Rendus*, Vol. cxiii., p. 637, and there is a previous paper by him in Vol. cxiii., p. 463, on the theory of turbo-machines.

UNDERGROUND RAILWAYS IN BERLIN.

DURING the last 20 years the necessity for more rapid and convenient communication between different parts of the city of Berlin has become more pressing. Elevated railways have been thought of, as the streets do not admit of an unlimited increase of rapid traffic. But they would involve a very heavy cost for acquiring the needful space. They are objectionable from an æsthetic point of view, and in addition they would seriously reduce the value of the adjacent plots of ground, especially in the better quarters of the city, and interefere with one of the main objects of the streets—the admission of air and light to the houses. The opposition of the manifold conflicting interests would occasion prolonged delay.

Hence, to provide within a measurable time means of communication which, whilst rapid, shall not interfere with the street traffic, there remains, as the last and most important expedient, the formation of underground railways. To this end the General Electric Company (Allgemeine Elektricitäts-Gesellschaft), has projected a system of underground lines for Berlin, and has submitted the plans and particulars to the authorities in a detailed memoir.

The construction of such lines is nowise novel. They have existed in London since the beginning of the sixties, and if so far they have found little imitation it is because it is unpleasant to be detained in an atmosphere contaminated by the emanations of the steam locomotives. Quite recently the application of electric energy has led to new undertakings and the electric line opened last year, connecting the city with the southern districts of London, is free from the drawbacks above mentioned. This success has excited attention not only in Berlin, but in Paris and New York, and during the next decennium various similar undertakings will doubtless be carried into execution.

According to the project of the Allgemeine Elektricitäts Gesellschaft, Berlin will be provided with a system of underground lines equally adapted to the interests of the entire community. The urban territory will be intersected by two lines following the main direction of traffic at right angles to each other. These are the underground lines from north to south, from Fennstrasse to Bergmannstrasse, and from east to west, connecting the new cattle station with Schœnberg. The four quarters of the urban territory thus formed are to be further connected with each other by two concentric circle lines. These four lines will supply a convenient communication between all parts of the city. Stations are provided at the crossings and at the most important stopping places.

The north-south line (Friedrichstrasse line) runs below the Friedrich and Belle Alliance roads. The east-west line (Leipzigerstrasse line) runs below the Landsberg, König, Leipzig and Potsdam roads. The crossing point of the two tunnels is the intersection of the Freidrich and the Leipzig streets. If we imagine circles drawn round this point with radii of respectively 2 and 4 kilometres, their circumferences will approximately show the course of the two ring lines. The inner line leads from the Halle Gate under the Königgrätz-Sommers streets and the Schiffbauerdamm to the Friedrichstrasse Station; from thence under the Park, the Exchange, the City Hall to the Curd Market, and through the Ross, the Prinzen and the Gitschiner roads, back to the starting point. The outer ring line is ultimately to form a connection between the Lützow Place, the Belle Vue, the Criminal Court, the Stettin Station, the Schönhaus Avenue, the Konig's Gate, the Silesian Station, the Cottbus Bridge, the Gräfe-Bergmann and Kreutzberg Strasse Schœneberg.

The several portions of the line will be carried out successively according to their relative importance, beginning with the Friederich Strasse line, which permits of the long-desired intersection of the street "Unter den Linden." Time fixed for the construction is eight years. Then will follow the Leipzig Strasse line and the inner circle line. The construction of the outer circle is less imperative and will be postponed until the other portions are completed.

The several portions are independent of each other and cross in tunnels placed one above the other. Separate tunnels are provided on each line for travelling in opposite directions. In order to avoid changing when passing into the opposite directions, the rails at the extremities take the form of loops. Thus, at the south end of the Friedrichstrasse line, the tunnel leading from the north leads from the Belle Alliance Place through the Bergmannstrasse, and thence through Zossenerstrasse back to the Halle Gate into the tunnel leading northwards. In this manner a meeting of two trains in opposite directions is rendered impossible, and all danger to the passengers is excluded.

In making the tunnels the ordinary method of constructing arches of masonry has been abandoned so as to be independent of the geological difficulties of the subsoil and of that worst enemy, the ground water.

The tunnels will consist of tubes of cast iron. These mighty tubes of an oval section, 10 mm. (?) in thickness, 3½ metres in height and about 3 metres wide at the bottom, will lie at from 8 to 15 metres below the surface of the earth, crossing the bed of the Spree more than 2 metres below its bottom. In consequence of their depth they will be secure from frost. They will consist of several curved plates of iron screwed together at their flanges so as to be water tight. By an ingenious device they will be thrust into the earth, and the soil will then be removed out of them. The free space left between the tunnel and the surrounding earth will be filled with concrete. The interior of the tube will be lined with the same material, which will prevent rusting. This method of working is very advantageous for a great city, as all the operations will go on unnoticed without interfering with the traffic. The rails lie on the sole of the tunnel at the distance of 1 metre. Nobody will be able to reach the connecting wires of the electric current for propelling the trains, for lighting the tunnel, for working the signals, &c. As motive power electricity will, of course, be used.

Leaving out of the question the reduction of working expense, the public will be free from all annoyance of fumes, heat and noise. The use of accumulators is for the present not proposed. The system to be employed approximates to that which the same company has successfully introduced at Halle. Single cars, however, will not run as on the tramways but small trains; in each train there will be three passenger carriages. They rest in front and behind each upon two pairs of axles; they have a gangway for the passengers from end to end, and have room for 40 persons each. Each car does not, as at Halle, contain a separate motor, but independent engines are used to draw the three cars, which may be called electric locomotives. Since they serve not to generate, but merely to apply the current, their construction is very simple. They merely contain several slow speed electromotors, along with the necessary regulators and brakes, and a place for the conductor. The rotation of the axles of the motors is communicated to the wheels of the locomotive, and thus the entire train is set in motion. The necessary electric energy is generated in central stations and distributed over the entire net. These centrals supply at the same time current for lighting the train and the tunnels, for the signals, the lifts, and the ventilators.

The trains succeed each other at intervals of three minutes, and have a speed of about 25 kilometres hourly. This high speed assists in ventilating the tunnel which is further effected by ventilators driven by electricity.

A point which required much care was the arrangement of stairs for access. The stations situate underground are in the space of about 10 metres in width between the parallel tunnels. The access for the public is very simple, like that for the City Railway, only the lifts convey the passengers downwards instead of upwards. The lifts hold 40 to 50 persons; stairs are also provided. The stations are brilliantly lighted electrically, and will give satisfaction at once from an architectural, an æsthetic and a sanitary point of view. The Friedrichstrasse line will be traversed in about 20 minutes. The total length of the double journey is 13 kilometres. The estimate for the construction is 12 million marks.

SURVEYING FOR A SUBMARINE CABLE IN THE PACIFIC.*

THE United States steamer *Albatross* has ended the first half of the survey of the bed of the ocean for a submarine cable between San Francisco and Honolulu, which was authorised by a special appropriation of $25,000 made by the last Congress. It is considered quite impossible to run a cable from San Francisco direct, for the reason that a plateau or shelf extends out for a distance of about 60 miles, with an average depth of only 100 fathoms; but at that point the depth suddenly increases to 1,200 fathoms, proving the existence of a precipice that would soon ruin, if not sever, any cable. In fact, the whole coast of California does not offer more than a half dozen places suitable for a cable landing. But comparatively few stretches of sandy beach, free from outlying rocks, exist along the coast, and by far the greater portion of the shore waters are shallow, and the bottom is besprinkled with sharp rocky projections. In the Bill making the appropriation, Congress designated San Francisco as the point from which the cable should be laid, but a poorer location is not to be found on the Pacific coast. It happens, however, that the most eligible site existing is the one nearest San Francisco. This place, which is generally known as Moss Landing, though the Government charts designate it as Salinas Landing, is almost in the centre of the long, clear, sandy beach circling Monterey Bay, and at a point about one mile south of the mouth of the Salinas river. The bay has practically no shipping traffic, hence no injury is to be feared from dragging anchors.

It was determined, therefore, that the survey should commence from Salinas Landing, and accordingly the *Albatross*, with Lieutenant Tanner commanding, left San Francisco on October 9th at daybreak, arriving there at two o'clock the afternoon of the same day. The remainder of this, as well as the following day, was spent in "swinging ship" to determine the magnetic error of the compass, an important matter where absolute accuracy is essential. On the following morning the *Albatross* started the survey, and it was found that the bottom consisted of a dark mud slightly mixed with sand, and that the depth gradually increased at the rate of about 50 fathoms to the mile for the first 14 miles. The soundings were made in a direction a trifle southward of west at intervals of a mile, describing a great circle course towards the Sandwich Islands. The depth gradually increased until 2,112 fathoms was reached at a point 725 miles west of Monterey. Thence the depths fluctuated over an undulating bottom between 2,600 and 2,900 fathoms for the next 250 miles, sounding stations being made at intervals of 10 and 15 miles, and the changes noted being quite gradual, seldom exceeding 100 fathoms in 15 miles. On the morning of the 17th, however, a change both in the character of the bottom and depth was encountered, the line passing over an area, the bottom of which was principally

* *Western Electrician.*

decomposed lava and the depths were slightly shallower, though no indications were met of the existence of a barrier to the successful laying of a cable over the region. The lava specimens secured were in small particles about the size of a pea and readily crumbled to the touch. This area extended on the line between 75 and 100 miles to the eastward of Belknap Mountain, a submarine volcanic peak whose summit approaches to within 388 fathoms of the surface of the sea, rising from the ocean bed 2,600 fathoms below. This peak was discovered by Admiral Belknap, whose name it bears. The *Albatross* passed about 40 miles to the northward of Belknap Mountain on the 16th inst., and obtained soundings in depths averaging 2,600 fathoms.

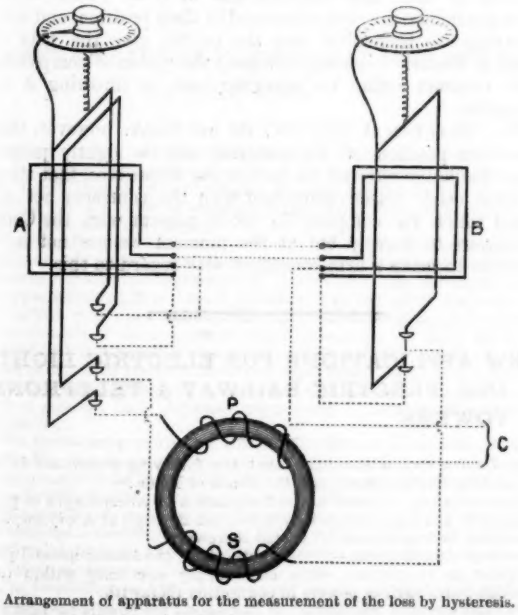
With the exception of the lava bed mentioned, the bottom from the start to the point where the last sounding was made (850 miles off Salinas landing) was uniformly muddy, and will make an exceptionally good bed for the cable, as it will sustain the least strain when resting easily and deeply in a bed of yielding soil. The mud allows the cable to sink well into it, protects it from rapid and consequently dangerous changes in temperature, from the sweep of strong currents and from the attachment to it of submarine growths. It also precludes the necessity of anchoring the cable.

The number of soundings taken by the *Albatross* was 98, and everywhere below 2,000 fathoms an uniform temperature of 35° Fahrenheit was found, proving the absence of submarine currents likely to move a cable.

THE MEASUREMENT OF THE LOSS BY HYSTERESIS.*

By THOS. SPENCER.

IT is necessary in the designing of a transformer that a thorough knowledge of the losses in the material used should be known, especially one which represents such a large part of the total loss as that by hysteresis. The loss from this cause varies greatly with the kind of iron used, and also has different values for different maximum inductions in the same sample of iron. Prof. Ewing, who is in a great measure the father of this subject, has given us several tables where the loss in watts per unit of volume is given for different kinds of wire for various maximum inductions, which have been very useful to the engineer. These tables were calcu-



Arrangement of apparatus for the measurement of the loss by hysteresis.

lated by measuring the area of his celebrated hysteresis curve; for each value given in the tables one of these curves had to be plotted from a great many observations. Now, what is wanted is some method which will abridge some of this work, and one which will not require such care to get accurate results.

The method I propose is based on two especially-designed electro-dynamometers, the general arrangements of which, as well as the electrical connections, are shown in the accompanying engraving. The dynamometer, A, has a double stationary coil of an equal number of turns, and a double suspended coil, also of an equal number of turns, rigidly connected together so that they will turn as one coil, but so arranged by means of the four mercury cups as to be electrically independent. These coils are each connected in series with one of the fixed coils; they are also connected with the two coils on the test ring, P and S, which we will call the primary and secondary, having an equal number of turns.

The current which is supposed to be located at C must be an alternating current of known period and one following the sine law as nearly as possible, and should be so arranged as to be controlled by a rheostat so as to obtain the greatest possible range of readings.

The second dynamometer, B, has its stationary coils precisely like A, but its suspended coil is single, and through this coil the secondary current alone passes. The connections of the stationary coils can be seen from the figures. Now, Maxwell has shown in his "Treatise on Electricity and Magnetism" that the energy stored in an electro-magnet per unit of volume, if the magnetic force, H, and the magnetic induction, B, have the same direction, is equal to $-\frac{1}{8\pi}$ H B. Now, if we designate this value by E, we have for the increment of energy per unit of volume

$$d\,\mathrm{E} = -\frac{1}{8\pi}(\mathrm{H}\,d\,\mathrm{B} + \mathrm{B}\,d\,\mathrm{H}).$$

Now, if we integrate this equation for Prof. Ewing's cycle, we see that

$$\int \mathrm{H}\,d\,\mathrm{B} = \int \mathrm{B}\,d\,\mathrm{H},$$

because both stand for the area of the same closed curve, and therefore are equal to each other, and we have

$$\mathrm{E} = -\frac{1}{4\pi}\int \mathrm{H}\,d\,\mathrm{B}.$$

Now, as the current is alternating, B is a function of the time, t, and if we represent by E^1 the loss in watts per unit of volume per unit of time, we have,

$$10^7\,\mathrm{E} = -\frac{1}{4\pi}\int_0^1 \mathrm{H}\,\frac{d\,\mathrm{B}\,d\,t}{d\,t}, \qquad (1)$$

Referring again to the figure and defining the following symbols:

i_1 = Primary instantaneous current in ampères;
i_2 = Secondary instantaneous current in ampères;
N = Number of turns in the primary or secondary;
R = Resistance of secondary current in ohms;
C = Mean circumference of the test ring in centimetres;
s = Curve section of test ring in square centimetres;
a = Constant of the dynamometer, A;
θ = Angle through which torsion head is turned in A;
a^1 = Constant of the dynamometer, B;
θ^1 = Angle through which the torsion head of B is turned.

Now, we have for the dynamometer, B,

$$\int_0^1 (i_1 + i_2)\,i_2\,d\,t = a\,\theta. \qquad (2)$$

But we also know that

$$\frac{4\pi\,s\,\mathrm{N}}{10\,\mathrm{C}}(i_1 + i_2) = \mathrm{H}, \qquad (3)$$

remembering, of course, that H and B stand for the instantaneous values of these quantities.

Also we have, assuming that the secondary has no self-induction,

$$10^8\,\mathrm{R}\,i_2 = s\,\mathrm{N}\,\frac{d\,\mathrm{B}}{d\,t},$$

substituting these two equations in (2) we have

$$\frac{1}{4\pi}\int_0^1 \mathrm{H}\,\frac{d\,\mathrm{B}}{d\,t}\,d\,t = \frac{10^7\,\mathrm{R}\,a}{\mathrm{C}}\theta.$$

Comparing this with equation (1) we see that

$$-\mathrm{E}^1 = \frac{a\,\mathrm{R}}{\mathrm{C}}\theta. \qquad (4)$$

* *Electrical Engineer*, of New York.

For the dynamometer, A, we have

$$\int_0^1 (i_1 + i_2)^2 \, dt = a^1 \theta^1 ;$$

that is, by (3),

$$\left(\frac{10\,C}{4\,\pi\,S\,N}\right)^2 \int_0^1 H^2 \, dt = a^1 \theta^1.$$

But assuming that H is a simple periodic function of the time whose maximum value is H^1, we have

$$H^2 = 4 \left(\frac{\pi N}{10\,C}\right)^2 a^1 \theta^1, \qquad (5)$$

Equation (4) and (5) furnish us (ignoring the minus sign of E^1 in (4), a means with these special forms of dynamometers of finding the hysteresis loss for any given magnetising force.

It can be easily seen that as i_1 and i_2 have phases differing by 180°, that $i_1 + i_2$ is very small in comparison to i_1 or i_2. So it is advisable to use as little iron (which, of course, must be laminated) as consistent with good results, and also to take the precaution to make the dynamometers with as large a current capacity as can be done without much reducing their sensitiveness.

REVIEWS.

Heroes of the Telegraph. By J. MUNRO. London: The Religious Tract Society.

The biographies given in this book are those of Wheatstone, Morse, Thomson, Siemens, Jenkin, Reis, Bell, Edison and Hughes. In an appendix brief accounts are given of Gauss, Weber, Cooke, Bain, Werner Siemens, Clark, Du Moncel and Elisha Gray. It is perhaps needless to say that the matter is vigorously and entertainingly written in Mr. Munro's happiest style. The illustrations are perhaps hardly as good as might be wished, but the whole book as it stands will be appreciated not only by the general public, but by those whom the science has brought into more or less intimate contact with the persons the details of whose lives are narrated.

A First Book of Electricity and Magnetism. By W. PERREN MAYCOCK. London: Whittaker & Co., 2, White Hart Street, Paternoster Square.

The work is written for the use of elementary science and art and engineering students, and general readers, and it is of the usual class of books written by ambitious science class teachers. It is natural enough that those who teach should prefer that their students should work according to their own ideas of thinking, and consequently there is much to be said for each teacher having his own text-book, and it is seldom that there are not some novel points to notice in the same. Mr. Maycock's book can be recommended as being decidedly good of its kind, and students who purchase a copy, and carefully study it will obtain an excellent ground-work of the science.

Testing of Insulated Wires and Cables. A Practical Guide. By HERBERT LAWS WEBB. New York: D. Van Nostrand Company. London: E. and F. N. Spon.

This book is really a reprint of a series of articles which first appeared in the *Electrical Engineer* (America). There is not, perhaps, much that is original in the work, but it being practically an abbreviation of larger treatises on the subject, the author has, however, put much practical matter in a handy and concise form, and the book should undoubtedly be useful to those who have not the time or desire to study the more elaborate works which explain in minute detail the theoretical "why and wherefore" of the subject. The book is divided into 17 chapters, as follows:—I. The Principles of Electrical Testing. Explanation of the different tests. II. Galvanometers. The Thomson reflecting galvanometer; its construction and use. III. Galvanometers (*continued*). Shunts and shunt formulæ. IV. Keys. Battery, discharge, short circuit and reversing keys. V. Resistance Boxes. High resistance and Wheatstone Bridge. VI. Wheatstone Bridges. Post Office pattern. Astatic detector galvanometer for use with bridge. VII. Condensers. Their construction and the laws governing capacities of condensers connected in series and in parallel. VIII. Testing Batteries and Accessories. Battery Connections. Connections for leads and earth on testing table. IX. Practical Testing. The galvanometer constant. X. Test for Insulation. XI. Insulation Testing (*continued*). XII. Insulation Testing (*continued*). XIII. Test for Capacity. XIV. Test for Conductor Resistance. XV. Connections of Permanent Set of Testing Instruments. XVI. General Remarks. Simple Rules for Connecting Up. Care of Instruments. XVII. Records and Reports of Tests. Specimen Test Sheets.

ELECTRIC LIGHTING IN THE CITY.

WE referred to this matter in our columns last week, and we now understand that the letter addressed by the Secretary of the City of London Electric Lighting Company to the Commissioners of Sewers contains a request that twelve months' extension of time be granted for completing the contracts entered into in 1890. From the *City Press* we learn that the writer of this letter pleads that the present company came into existence in July last, when only six months of the obligatory period remained unexpired. "Nearly everything remained to be considered and done in preparation for the large expenditure of capital." It was thought necessary to call in the very best advice, but it is hinted—if not absolutely stated—that the technical inquiries are not yet completed, and therefore little has been done. Probably the key to the position, says our contemporary, is to be found in the reference to the provisional orders which give the company Parliamentary authority as well as the authority of the Commissioners of Sewers to undertake private lighting. It is notorious that the street lighting is to be carried on at an actual loss to the company, whose recoupment is to come from the profit made on private lighting.

When the contracts were originally made, the time required was fixed by the companies themselves. There was no talk of outside technical advice then. They themselves considered the time ample for their purposes. The contracts are drawn in such a fashion that it is difficult to define what is the penalty attaching to delay—but there is a penalty, and there is no doubt the contracts will be voided unless the Commissioners of Sewers consent to the extension.

The consideration of this request will come before the Commission at their next meeting, and we (*City Press*), think these gentlemen may rest contented in their position, and with advantage to themselves and the public, give the City of London Electric Lighting Company the option of completing their contract within the specified time, or throwing it up altogether.

We (ELECTRICAL REVIEW) do not think, however, that the exact position of the company can be rightly judged from the letter referred to, as it is our impression that there is some other reason connected with the contracts not yet stated which the company do not at present wish the Commissioners to know; but at the moment we are not in a position to make a firm statement with regard to this.

NEW APPLICATIONS FOR ELECTRIC LIGHTING, ELECTRIC RAILWAY & TELEPHONE POWERS.

THE *London Gazette* announces that the following powers are to be applied for to Parliament, and the Board of Trade:—

ABERYSTWYTH.—Power to the Corporation of Aberystwyth to produce, store and supply electricity within the Borough of Aberystwyth; also other various powers connected therewith.

ASHTON-UNDER-LYNE.—Powers authorising the Ashton-under-Lyne Corporation to produce, store and supply electricity within the borough; also various powers in connection therewith.

BOURNEMOUTH.—Application to Parliament for powers for lighting Corporation property by electric light.

FINSBURY PARK AND CITY.—Application to Parliament authorising the Great Northern and City Railway to construct underground railways from Finsbury Park to the City; also other incidental powers.

HACKNEY.—Provisional order to authorise the East London Electric Supply Company, Limited, to supply electricity for public and private purposes, within the Hackney district; also other various powers connected therewith.

HALIFAX.—Powers to the Corporation of Halifax to produce, store and supply electricity within the borough, also various other purposes connected therewith.

HAMPSTEAD, ST. PANCRAS AND CHARING CROSS.—Application to Parliament for powers to construct underground railways from Hampstead to Charing Cross, with branch to Euston, St. Pancras and King's Cross. The motive power to be employed will be cable traction, electric, or any other motive power than steam locomotives.

HARWICH.—Provisional order enabling the Corporation of Harwich to produce and supply electric light for public and private purposes within the borough; also for various other purposes connected therewith.

ISLINGTON.—Application to Parliament by the City and South London Railway Company for powers authorising the extension of the electric railway to Islington; also construction of foot subways; also other incidental powers.

LAMBETH.—Application to Board of Trade authorising the Lambeth Vestry to supply electricity within their parish; also various other powers.

MORECAMBE.—Application to Board of Trade for powers authorising the construction of additional tramways in the township of Poulton Bare and Torrisholme, Lancaster; power to use electrical power thereon, and on previously authorised tramways.

NEWBURY.—Powers to the Corporation of Newbury to produce, store and supply electricity within the borough, also various other purposes connected therewith.

ST. PANCRAS.—Application to Parliament for additional power to borrow money, and alterations under the Electric Lighting Act, 1892; also amongst other powers, to appropriate certain ground for the construction of chambers for accumulators and transformers of electricity.

SHEFFIELD.—Provisional order to authorise the Sheffield Telephone Exchange and Electric Light Company, Limited, to supply electricity and electrical energy for public and private purposes.

SUTTON.—Application to Board of Trade for urban sanitary authority to produce, store and supply electricity within the urban district of Sutton, Surrey.

TELEPHONES.—Application to Parliament by the New Telephone Company, Limited, for powers authorising the placing of telephone mains underground, and the erection of wires, posts and standards, &c., over and in streets, lands and buildings, also other incidental powers.

WALTON-ON-THAMES—Provisional order to authorise the Weybridge Electric Supply Company, Limited, to supply electricity for public and private purposes within a part of the parish of Walton-on-Thames, Surrey; also other incidental powers.

WATERLOO AND CITY RAILWAY.—Application to Parliament for powers to construct an underground railway or subway from near Waterloo Station to Mansion House Street. Agreements as to and power to supply electricity, or electrical energy or power.

WEST HAM.—Provisional order enabling the Corporation to produce and supply electric light for public and private purposes within the county borough of West Ham; and also other incidental powers.

WOKING.—Application to Board of Trade for provisional order authorising the Woking Electric Supply Company, Limited, to produce, store and supply electricity, also power to construct works, &c.

CRYSTAL PALACE ELECTRICAL EXHIBITION OF 1892.

A MEETING was held at the Mansion House of the Honorary Council of Advice, on Wednesday, November 25th, under the presidency of the Right Hon. the Lord Mayor, to consider the best method of making the exhibition of scientific value, and to receive the following report from the directors:—

During the past ten years enormous strides have been made in electrical engineering, and electricity has formed the subject of legislation in the Electric Lighting Acts of 1882—88; but although much has been achieved, it is highly probable that the great majority of the British public are still unaware of the vast extensions and present developments of this important branch of science. Electric lighting in 1881 was commercially successful only to a limited extent; after years of scientific research, however, experiments have culminated in important inventions, and science has now placed the industry in such a position that electrical engineering is capable of universal adaptation.

The forthcoming exhibition will afford a favourable opportunity for conducting test experiments; and it is believed that tests undertaken at the present time by a public body will be of great service both to the scientific world and to the industry at large.

The directors considered that the present was an opportune moment for once again throwing open the Palace for the purpose of an electrical exhibition, thus affording an opportunity for the public to see the latest advances in electricity.

The Exhibition of 1881 is recognised as the pioneer of electrical engineering in this country, and it is confidently believed that the Exhibition of 1892 will be remembered in history as showing that the infant Electra has grown to years of maturity, and is capable of further aiding science, commerce, and the world at large.

The forthcoming exhibition, which will be opened on January 1st, 1892, may be conveniently divided into three great divisions, each of which will be subdivided into sections.

The first division will represent the modern form of heavy electrical engineering as now used for electric lighting, under which will be shown the latest and most approved machinery for generating powerful currents of electricity.

The second division will be devoted to the utilisation of electric currents other than for lighting, such as the transmission of power, the application of electro-motors to railways, lifts, cranes, launches, pumps, fire engines, hauling machines for mines, &c.; also the use of the current for electro depositing, smelting, welding, and the storage of electricity.

The third division will include the generation and utilisation of electric current from primary batteries, in connection with telephony (including switchboards and connections for cities), telegraphy, as used for land and submarine purposes, electricity in therapeutics, and for other purposes.

The space available for the above purposes, though large, has been over applied for, and every section of the industry will be well represented.

In order to add to the value of the official catalogue of exhibits, the directors have decided to introduce descriptive articles at the commencement of each section. These articles will be written in non-technical language by an electrical engineer of experience, so that the public may be able to understand more fully the meaning of the various exhibits.

Invitations will be issued to public bodies throughout the United Kingdom to visit the exhibition, where the various systems of electric lighting will be on view, and in this direction alone very great saving of expense to the authorities will be effected, and other advantages must also accrue.

The manner in which the proposal for this exhibition has been received and supported by electrical engineers, the assistance anticipated from the honorary council of advice, from the committee appointed by the London Chamber of Commerce, and from the Institution of Electrical Engineers, all justify the belief that even more interest will be shown in the present effort to popularise electric lighting and electromotive power, than was evinced by the public in the successful Exhibition of 1881.

After the SECRETARY had read the report,

The LORD MAYOR (Alderman Evans), in welcoming the Honorary Council, said he regarded the movement as a very important step in the right direction. As the chief magistrate of the City of London, anything that affected the subject of lighting was of considerable interest to him. He regretted that in the City, owing to various causes, they had been exceedingly backward in adopting the electric light, but he trusted that the apathy of the past would soon be corrected, and that they would enjoy in the City the comfort and luxury of such progress. He was interested not only in the lighting of the City, for, as he would be shortly going into residence in the City, he was very desirous of securing the electric light at the Mansion House. In this matter he was glad to hear from the Duke of Marlborough that he need have no doubt in the matter of the forthcoming supply. The report of the committee was a very exhaustive one, and indicated the lines on which it was proposed to make the exhibition. They had his best wishes for the success of the undertaking, and in conclusion he promised his assistance.

Mr. W. H. PREECE said he had been asked to bring before the meeting the proposition of making the forthcoming exhibition of scientific value. During the past ten years very great progress had been made both scientifically and practically in applying electricity, not alone to the purpose of light, but in the transmission of power from different places, and thus utilising the waste powers of nature. The development of the heat by electricity would play a most important function in the future. In the forthcoming exhibition they would have the practical applications brought before them. The practical applications of electricity to the wants of mankind was only limited by the inventive genius of those who were engaged in studying the science, and also limited by the ignorance of the times; it was really in imparting knowledge of the wonderful applications of electricity that exhibitions like the proposed one at the Crystal Palace seemed to do more good than anything else. They had had exhibitions like that taking the place very much of an educational establishment; they had also means by which they who were experts could study the progress made by other people. The Crystal Palace Exhibition would be purely national, and thus English engineers would have an opportunity of exhibiting without prohibitive tariffs. In the forthcoming exhibition they had to show as far as they could the developments of electricity, and also to show the efficiency which had been secured; they had also to bring forcibly before the scientific and commercial world the economy that had been effected. When he stated that electricity was as cheap as gas, it might be doubted, but those who had adopted the electric light, and considered its many advantages, had found that there was no difference in out-of-pocket expenses between electricity and gas. It was in showing the many advantages attaching to the use of the electric light that the exhibition was going to perform very important functions. It was a sanitary object they had in view, and the subject could not be too strongly enforced upon the people. The organisers of the exhibition had desired him to propose certain gentlemen to act as a committee for testing the various exhibits. The speaker concluded by proposing the following gentlemen as a testing committee:—* Prof. W. Grylls Adams, D.Sc., F.R.S.; Prof. W. E. Ayrton, F.R.S.; Major P. Cardew, R.E.; Prof. W. Crookes, F.R.S.; Sir James N. Douglass, F.R.S.; W. B. Esson, Esq.; Prof. D. E. Hughes, F.R.S.; Gisbert Kapp, Esq.; Prof. A. B. W. Kennedy, F.R.S.; W. H. Preece, Esq., F.R.S.; Prof. J. Perry, D.Sc., F.R.S.; Prof. Silvanus Thompson, D.Sc. F.R.S.

The DUKE OF MARLBOROUGH next spoke at considerable length on the commercial prospects of electric lighting, after which the motion was carried.

Mr. GARDNER, on behalf of the Crystal Palace Company, thanked the Lord Mayor for presiding, and the proceedings were brought to a close.

* One or two of the above names may possibly be altered.

NOTES.

Lighting of the Port of Fiume.—After many experiments, the permanent electric light installation of the port of Fiume has just been inaugurated.

Birmingham Cattle and Poultry Show.—It is stated that the electric light will be used in the Poultry and Pigeon Department at the above show, as it is found much more conducive to the health of the birds than gas.

The Royal Society.—The following paper was announced to be read, yesterday, before the Royal Society:—W. M. Bayliss and Dr. E. H. Starling "On the Electromotive Phenomena of the Mammalian Heart."

Liverpool Electric Lighting.—It is announced that the Liverpool Electric Supply Company, Limited, intends making application to the Board of Trade on or before the 21st of next month for a provisional order to repeal, alter, or amend all or some of the provisions of the Liverpool Electric Lighting Order, 1889, and of the Liverpool Electric Lighting Order, 1891, and to extend to the area of supply comprised in the said Liverpool Electric Lighting Order, 1889, all or some of the provisions of the Liverpool Electric Lighting Order, 1891.

Electric Light Litigation in France.—An important electric lighting case came before the Perpignan Prefecture Council last week. It was an action brought by the authorities of the town against M. Edmond Bartissol, deputy for Ceret, an electric lighting contractor. M. Bartissol in his contract undertook to light Perpignan with the electric light before May 1st, 1890. As he did not carry this out, the authorities claimed 300,000 francs damages from him, and 500 francs per day during the delay. M. Bartissol claimed 16,000 francs from the authorities, and the cancelling of the contract, if they cannot bring to an end the resistance of certain owners who object to the placing of brackets used in the lighting on the façades of their houses. After hearing counsels' speeches, the case was adjourned.

Proposed Electric Lighting for Guildford.—With reference to the proposed lighting of certain houses in the town by electricity, a deputation waited on the Guildford Urban Sanitary Authority last week. The deputation explained that a number of people in the town wanted the electric light, and various ways in which it might be obtained had been suggested. They had no powers such as a company would have, and could only work by consent. They would not be a company trading for profit, and the cost of production of the light would be divided amongst the consumers. They proposed to use the low tension system. At the Council meeting the following resolution was proposed, "That it is expedient that the Council should reserve to itself full powers to proceed at any time to acquire a provisional order for lighting the district by electricity, and that any facilities given to a private company should be attended with conditions which will safeguard the future interests of the Council in this direction." After a discussion it was agreed to refer the whole matter of the resolution and the application to a committee of the whole Council.

National Telephone Company, Limited.—It is announced that the National Telephone Company intend making application to Parliament in the ensuing session, for an act authorising the company, or their agents, to carry wires for telephonic communication over, along, and across highways, streets, footpaths, and other public places, and houses or lands within the United Kingdom; powers to break up streets and erect posts on any street, house, land, or other place within the United Kingdom; to make provisions in relation to wires over private property; powers to public bodies, local and other authorities, and companies to enter into agreements for facilitating telephonic communication; powers of supervision to Board of Trade or other public bodies, local and other authorities; rates and charges; bye-laws; to authorise the granting and accepting of licenses and for other purposes; if so determined, to dissolve the company, and to incorporate the shareholders of the dissolved company with other and extended powers; incorporation and amendment of Acts.

The Electric Light and Compressed Air in Munich.—It is stated that a German company has submitted a project for a compressed air installation in Munich, which in addition to supplying motive power is intended to provide for the electric lighting of the city. The total installation capital has been fixed at 4,200,000 marks, the total annual expenditure at 550,000 marks, the total length of the conductors will amount to 65,000 metres.

Electric Lighting at Baildon.—At a meeting of the Baildon Local Board last week, the clerk reported that he had visited Weybridge and inspected the electric light installation, as instructed, for the purpose of laying facts before the board which would enable them to consider whether that illuminant might be utilised for lighting Baildon. The electric light in the town named was as cheap as gas; plant had been laid down at a cost of £6,000. A definite consideration of the matter was adjourned in order that the clerk might obtain some further information.

The Microphone Attachment to Telephones in America.—A Washington telegram states that a patent has been granted to the Bell Telephone Company for the Berliner microphone attachment to telephones giving the company virtual control of the telephone business of the country for 17 years. The patent has been lying at the patent office since 1877, but the application for a patent has been delayed until now, when all other telephone patents are about to expire. The stock of the Bell Company rose $12 in one hour in consequence of the issuing of the patent. It is considered doubtful, in view of the circumstances of the long delay in its issue, whether the United States Courts would sustain it to the extent of permitting its owners to enjoy its protection for the next 17 years.

Electricity in Russia.—It is announced that an electrical exhibition, organised by the Imperial Polytechnic Society of Russia, will be held in St. Petersburg next month, and will remain open until March, 1892. The principal object of the exhibition is the adoption of the system of lighting best adapted to the principal towns of the Empire. Foreign firms are invited to exhibit.

A Simple Alternate Current Motor.—We hear that a practical and simple alternate current motor has at last been invented and tested in America. There are two types, the non-synchronous, invented by Mr. Kelly and Mr. Stanley, and the synchronous by Mr. Kelly and Mr. Reginald A. Fessenden. The motors are to be made by the Stanley Company at Pittsfield. Both have a very strong starting torque, and efficiencies of over 90 per cent. by actual running test. The method by which the self-induction is eliminated from the armature is very simple, and entirely new in theory; it is due to Mr. Kelly.

New Book.—Mr. John B. Verity, M. Inst. E.E., has just finished a book on the production and application of electricity to light, power, and traction. It is written in a popular and non-technical manner, and deals also with the various methods of distributing electricity, and gives full particulars of the different public supply companies both London and provincial, showing their capital, shares taken, number of lamps supplied, and area covered. The book, which will be entitled "Electricity Up to Date," will be fully illustrated, and contain a map showing the districts allotted to the various London supply companies, and will be issued by Messrs. F. Warne & Co.

The Proposed Elevated Railway in Berlin.—It was reported in Berlin last week that the project for the construction of a high level electric railway in the city has assumed definite form. Detailed negotiations have taken place between the chief magistrate, the chief of police, the Ministerial Architectural Commission, and Messrs. Siemens and Halske, and the proposal has been accepted. According to the report, Messrs. Siemens & Halske will, now that the consent has been given, work out the project and lay it before the authorities. The line is to form a connection between the Zoological Gardens Station and the Warschauerstrasse (near the Silesian Station) and the Wasserthor and Dennetwitzplatz stations.

Railways in New South Wales.—All the through and important trains on the New South Wales Government railways are now fitted with electrical communication between passengers and guards.

The Electric Light in Battersea.—The extensive works at Battersea of the Morgan Crucible Company, Limited, are being installed throughout with the electric light. The work is in the hands of Messrs. Mather and Platt, Manchester.

A New Alternating Dynamo.—The Royal Electric Company, of Peoria, Ill., are making new alternating dynamos, the main feature of which is that the field magnets are placed in the centre, and surrounded by the armature coils.

Swan United Electric Light Company.—It is said that negotiations are in progress for the transfer of the business of the Swan United Electric Light Company to the Edison and Swan Company. As the patents of the former concern have only three years to run, a City contemporary asks what the Edison Company is to buy?

Electric Tramways at Bradford Proposed.—It is intended to try experiments with electric tramways in a few weeks in Cheapside, Bradford, one of the steepest streets of the town. The future tramway policy of the corporation will be largely influenced by the success or otherwise of the experiments.

Sudden Death of a Post Office Engineer.—A cyclist named Mills was found in the roadway near Dover on Monday afternoon by a countryman, with his bicycle lying upon him. The countryman waited near him half an hour, hoping for assistance to arrive, and when help was forthcoming Mills was dead. Death is supposed to have occurred from heart disease. He was chief engineer on Her Majesty's Post Office steamer *Lady Carmichael*, at Dover, and leaves a wife and family.

Sheffield and Electric Lighting.—We learn from a contemporary that the Sheffield Telephone Exchange and Electric Lighting Company have given notice under the Electric Lighting Acts, of their intended application, to which the Corporation have assented, for a provisional order from the Board of Trade, authorising them to produce, store, sell, supply, and distribute electricity, to supply electrical energy and power, and to supply electricity direct or otherwise for motive, telegraphic, telephonic, electrolytic, sanitary, and any other purposes.

Water Power in Switzerland.—It is said that a concession has been awarded by the Berne Canton to Herr Müller-Laudsmann, of Lotzwyl, to use the water power for the river Aar at Wynau for electrical purposes, by means of a canal 1,000 metres long which can be easily constructed, having a fall of 37 metres, developing 3,000 horse-power. This motive force, it is said, will meet with ready application in the thickly populated districts of central Switzerland; it is moreover intended to work the proposed Valsthal Langenthal electric railway. Should the force mentioned be found in course of time insufficient, it can without difficulty be increased to 6,000 horse-power, as the whole of the water included in the concession has a fall of 85 metres.

The Quality of the Electric Light.—On Thursday evening, November 13th, at a meeting of the Chemical Society, at Burlington House, Captain Abney, C.B., F.R.S., gave an exceedingly interesting lecture, entitled "Colour Photometry." Incidentally, during the course of this lecture the gallant captain paid a very high tribute to the quality of the electric light, which he said was more constant than any other source of light, except, perhaps, oil. He preferred himself to employ electricity wherever possible, in his researches or lectures upon optical science, and he strongly advised the Fellows of the Chemical Society to use this adjunct in lantern work, or wherever an illumination of constant quality was required. Everyone knows that Captain Abney is one of our highest authorities in matters pertaining to light and colour, hence his statement concerning the quality of the electric light is the more significant.

Telephones in the United States.—A telephone trunk line, consisting of 50 wires, is at present being erected between New York and Chicago, and will shortly be completed.

The Electric Lighting of Fareham.—Notice has been given by the Fareham Electric Light Company of their intention to apply to the Board of Trade within the ensuing month for a provisional order conferring rights in respect of the supply of electricity for both public and private purposes within the district of the Fareham urban sanitary authority.

Church Lighting.—We understand that the church for the blind at Liverpool was lighted by electricity on Sunday evening last for the first time, with most satisfactory results, the difference in temperature and the purer atmosphere being most marked. The work has been carried out by the Liverpool Electric Supply Company, Limited.

The Prevention of Tramway Accidents.—The Portstewart Steam Tramways Company (in connection with the Belfast and Northern Counties Railway Company) have had some of their tramcars fitted with the Porri patent emergency brake, to act automatically in the event of a car breaking away from the engine, and also for application by hand when required. The brake was some time ago tested by Major-General Hutchinson, R.E., and approved by the Board of Trade. It has been further approved by the Board of Trade Inspector at Belfast, and the inventor (a Grimsby journalist) has just been informed by Mr. B. Malcolm, the company's engineer, that in the trials made to test it the brake proved satisfactory.

Progress of Electric Lighting in London.—Although at the present moment little is heard concerning the doings of our electric light companies, it is to be inferred that they are steadily nearing the end of building operations, when the companies, unfettered by the difficulties attendant upon new enterprises, will be able to supply the whole of the inhabitants of the allotted districts with electric current. There can be no doubt, judging from the growls of the public, that the laying of street mains is carried on with unceasing vigour. At the same time, some of the most important central stations are approaching completion, and will soon run at their full capacity. The Westminster Electric Supply Corporation, we notice, has got out of hand the station at Millbank, and Davies Street Station is nearly finished. The large station of this company at Eccleston Street, Victoria, is progressing rapidly, and will soon be one of the largest and best planned stations in London. The Vestry of St. Pancras has not been idle, inasmuch as it has built the Stanhope Street Station, and applied for a new loan to continue the work. Arc light standards have been erected down the centre of the Euston Road, and this district of London bids fair to be one of the earliest to have a constant supply of electricity.

The Efficiency of Electro-motors.—Mons. A. Gravier sends us the following communication, which tends to show that he does not keep pace with the times:—"The question of the efficiency of electric motors is one that has a great interest for me, on account of the contradictory assertions that are current—for some constructors claim for their machines 91 per cent., whereas some theorists say that an electric motor cannot give more than 50 per cent. For the first assertion see Hospitalier's formulæ, 1890, page 291, and for the second see the same work, page 293. In the face of these contradictory statements I shall be very glad to hear the authoritative voice of English science. Allow me, therefore, to ask plainly the question, 'Theoretically, what may be the electrical efficiency of a motor that is giving out its maximum power? Theory says that in order that this condition may be realised, E' must be equal to $\frac{E}{2}$, E' being the E.M.F. of the motor, E the E.M.F. of the generator, and so, in this case, the efficiency $= \frac{E'}{E}$; *i.e.*, is equal to 50 per cent. Is this theory correct? I ask the question in the hope that one of your readers will take the trouble to discuss it. It is of importance to the scientific world that theoretical conclusions should be rendered very clear."

Institution of Electrical Engineers.—On Friday, November 20th, a paper was read before the Students of the Institution, on "Lightning Conductors and Guards," by Messrs. H. C. Haycraft and C. Minshall.

Elementary Electricity.—Mr. Sinclair, an electrician in the employ of Messrs. Vivian and Sons, Copper Ore Works, Swansea, gave a lecture last week at St. David's Hall, Mumbles, on "Elementary Electricity."

The Electric Light at Blantenburg. — The electric lighting plant for the electric lighting of the streets of this town was recently put to work with great success. The work has been carried out by Messrs. Naglo Brothers, of Berlin.

The Electric Lighting at Hammerfest, Norway.—A *Daily Graphic* correspondent states that the most northern commercial town in the world—Hammerfest in Norway—which was recently totally destroyed by fire, has now been entirely rebuilt, and lighted up throughout with electric light.

Breakdown of Channel Cables.—We hear that three of the Channel cables have been broken, amongst them being that laid recently for telephoning between London and Paris. No communication has been possible for about a fortnight, but at the time of going to press the break is said to have been repaired.

Substitution for Platinum in Incandescent Lamps.—Some time ago we noticed a patent of Mr. R. A. Fessenden for an alloy in place of platinum in incandescent lamps. It may interest our readers to know that this is working practically very well, and the Sawyer-Man Company have made it a perfect success up to the present.

The Electrical Theory of Solution and Cohesion.—In our other columns will be found a letter from Mr. Reginald A. Fessenden, in which he replies to the objections made to his paper on the above subject (which recently appeared in the ELECTRICAL REVIEW) by Mr. Pickering. Mr. Fessenden's theory was not published in Europe, copies of the papers published in America having merely been sent to Professor Ostwald and others.

Electric Tricycle.—A correspondent writes:—"I think 'Wheels' will find working a tricycle with any of the present known storage batteries out of the question, but if he will communicate with me, I will endeavour to let him have an experimental battery that will give 250 per cent. more storage capacity than an E.P.S. with the same E.M.F., and which cannot be damaged by high rates of charge or discharge." We fear that this answer will not be of much use to "Wheels." If the experimental battery had 250 per cent. more storage capacity for the same weight, then probably something might be done with it, especially as it cannot be damaged.

The Magnetic Lady.—The *Evening News and Post* of Wednesday gravely announced that one of its reporters had interviewed Mr. Arthur Shippey, "a well-known scientist in electrical circles," on the subject of the "Little Georgia Magnet." Mr. Shippey asserts that a pair of well magnetised stays have an affinity for absorbing and storing electric current. He hints that the tingling sensation experienced by Mr. Verity, when in contact with the human magnet, might have been caused by leakage from the electric company's mains creeping up the Magnet's boots, and he suggests that the real solution of the mystery "opens up a new theory at present unknown to science, relating to a new system of producing electricity by the modern thermopolaic methods of generating current produced by the heat of the body by thermo-generation." The reporter could not induce Mr. Shippey to explain thermopolaic generation, so we would suggest that he should read that "well-known-scientist-in-electrical-circles" letter which recently appeared in the REVIEW, describing an old kitchen boiler, which was used as the basis of Mr. Shippey's marvellous experiments on railway train lighting. We know of no circle, electrical or otherwise, which Mr. Shippey has so "squared" as to entitle him to the claim of being one of its well-known scientists; but if anybody desires to enjoy a hearty laugh, let him procure a copy of our pink contemporary.

The American Fine Arts Society.—This society are having new offices and club-house erected in New York in West Fifty-seventh Street. The building is to be lighted throughout by electricity.

Hotel Lighting in Australia. — One of the finest hotels in Australia is that known as the Hotel Australia, in Sydney, New South Wales. This hotel is lighted throughout by electricity.

Telephonic.—Two wires are being run by the National Telephone Company from Glasgow to Greenock. This will make six public wires, and obviate inconvenience to the subscribers. The same company also propose putting a section of their lines underground in Glasgow.

The O. S. A. Smoking Concerts.—On Friday, December 4th, a concert will be held at the usual *rendezvous*, Mason's Hall Tavern, at 7.30 p.m. In addition to music, there will be recitations, humorous selections by the "Whistling Coon," and banjo solos.

The Electro-Harmonic Society.—This evening ushers in the first "Ladies' night" of the season. We feel sure that the vocalists, all new to the society, will be very highly appreciated, and the D minor trio of Mendelssohn will invest the evening with something of a classical character. Mr. Pritchard, whose humorous selection gave so much satisfaction at the opening smoking concert, will repeat his sketch, and the remainder of the programme will consist of solos on the piano, violin, and violoncello.

NEW COMPANIES REGISTERED.

Electrical Finance Corporation, Limited.—Capital £100,000 in £5 shares (of which 200 are founders). Objects: To construct, contract for, establish, carry on or to provide capital for companies, firms, or persons having for their objects the lighting of streets, places and buildings, public or private, by electricity, and if deemed advisable to carry on the business of an electric lighting company in all its branches. Signatories (with one share each): W. Martin, 12, Poplar Grove, West Kensington Park; R. Brooks, Sutton-on-Sea, Lincs.; A. T. Havers, 27, The Grove, Vauxhall, S.W.; Miss A. E. Munro, 42, Gordon Road, Stoke Newington; A. H. Venning, 24, Bromley Grove, Shortlands; F. Evershed, Forest Hill Tavern, Peckham Rye; J. H. Infield, 10, Bolton Gardens West, S.W. The number of directors is not to be less than three nor more than nine, the first to be appointed by the subscribers. Qualification 40 £5 shares or £200 stock. Remuneration £100 per annum each, and £100 additional for the chairman, to be increased according to profit. Registered on the 18th inst. by C. E. Baker, 22, Great George Street, Westminster, S.W.

Johannesburg Lighting Company, Limited.—Capital £150,000, in £1 shares. Objects: To acquire and carry on the business of the Johannesburg Gas Company, Limited, and with a view thereto to adopt an agreement with them; to manufacture, sell and supply gas and electricity for lighting, warming, motive power and other purposes, in the town of Johannesburg and elsewhere in Africa. Signatories (with 1 share each): W. F. Lance, 7, Grote's Place, Blackheath; W. G. Soper, Bury Street, St. Mary Axe, E.C.; A. Jones, 15 and 16, Bury Street, E.C.; W. H. Adams, 168, Friern Road, East Dulwich; E. T. Botwright, 11, Oxford Road, Gunnersbury; W. B. Butler, 2A, Sixth Avenue, W.; W. J. Yeoman, 89, Brayard Road, Queen's Road, S.E. The number of directors is not to be less than three, nor more than seven, the first to be nominated by themselves. Qualification, £250. Remuneration, £100 per annum each, and £200 per annum for the chairman. Registered on the 20th inst. by Ashurst, Morris, Crisp & Co., 17, Throgmorton Avenue, E.C.

International Electric Subway Company, Limited.—Capital £25,000 in £1 shares. Objects: To acquire, work and develop patents or patent rights connected with underground conduits or subways, whether electrical or

otherwise; to enter into contracts for the supply of such subways, or for the supply of electric light, electric power, or electricity generally. Signatories (with one share each): T. J. Ford, 35, New Broad Street, E.C.; R. Frothingham, 21A, Hanover Square, W.; A. Hickman, 51, Richmond Terrace, Clapham Road: E. C. Price, 109, Hanley Road, Crouch Hill, N.; A. E. Bantick, 48, Fentiman Road, Clapham; C. A. Hood, 8, Lacon Road, East Dulwich; G. H. Smith, 62, Ebury Buildings, Pimlico. The number of directors is not to be less than two nor more than five, the first to be appointed by the subscribers. Registered on the 17th inst. by John Hart and Holmes, 22, Great Winchester Street, E.C.

OFFICIAL RETURNS OF ELECTRICAL COMPANIES.

Crompton Electric Supply Company of Australia, Limited.—The annual return of this company, made up to the 10th inst., was filed on the 17th inst. The nominal capital is £50,000, divided into 9,500 "A" and 500 "B" shares of £5 each; 3,115 "A" and the whole of the "B" shares have been taken up, the "B" shares being issued as fully paid. Upon the "A" shares the full amount has been called, resulting in a payment of £13,765, leaving £1,810 unpaid. Registered office, Mansion House Buildings, Queen Victoria Street, E.C.

Electrical Date and Time Stamp Company, Limited.—The annual return of this company, made up to August 11th, 1891, was filed on the 17th inst. The nominal capital is £121,000, divided into 100,000 original and 21,000 new shares of £1 each; 6,893 original and the new shares have been taken up, and upon 2,393 of the original shares the full amount has been called, and, with the exception of £122 10s., paid. The remaining 4,500 original, and all the new shares, have been issued as fully paid. Registered office, New Broad Street House, New Broad Street, E.C.

Electrical Inventions Company, Limited.—The statutory return of this company, made up to the 6th inst., was filed on the 21st inst. The nominal capital is £35,000, in £1 shares, seven of which are taken up, but nothing has been called. No office has yet been registered.

Montevideo Telephone Company, Limited.—The annual return of this company, made up to the 13th inst., was filed on the 17th inst. The nominal capital is £220,000, divided into 29,000 preference and 15,000 ordinary shares of £5 each. 28,000 preference and all the ordinary shares have been taken up, of which 3,000 of each kind were issued as fully paid. The remainder have had the full amount called up, and all calls have been paid, realising £185,000. Registered office, 25, Abchurch Lane, E.C.

"Electrician" Printing and Publishing Company, Limited.—The annual return of this company, made up to the 12th inst., was filed on the 19th inst. The nominal capital is £10,000 in £10 shares, 940 of which are taken up. Of these 800 have been issued as fully paid. On the remaining 140 the full amount has been called, and all calls have been paid. Sir John Pender, 360 shares; Sir James Anderson, 140 shares; and Louis Floersheim, 190 shares, are the chief shareholders. Registered office, 1, 2 and 3, Salisbury Court, Fleet Street, E.C.

BUSINESS NOTICES, &c.

Electric Launch Building.—Mr. W. S. Sargeant, late manager of the Electric and Steam Launch Works, Strand-on-the-Green, Chiswick, has severed his connection by mutual arrangement with Messrs. Woodhouse & Rawson United, Limited. He is now carrying on business as an electric and steam launch builder, and laying down plant and machinery for the construction of electric motors for water propulsion, and compound surface condensing engines. Offices: Strand-on-the-Green, Chiswick.

J. B. Saunders & Co.—An installation of electric lighting has just been completed at Ty-Mynydd House, Radyr, by Messrs. J. B. Saunders & Company, of Cardiff. About 60 lamps are distributed about the house and stables and can be supplied either from accumulators or direct from the machine. The current is generated by a Phœnix dynamo driven by a horizontal 5 H.P. Priestman's oil engine.

Fyfe-Main Electric Lighting Company.—The electric light installation at the new offices of the *Field, Queen, and Law Times*, situate at Bream's Buildings, Chancery Lane, has just been completed, the whole of the work being carried out by the Fyfe-Main Electric Lighting Company, Brixton, under the direction of Mr. W. K. Parlington. The installation comprises upwards of 1,000 16, 32, 50 and 100-C.P., 100-volt incandescent lamps, and 9 15-ampère arc lamps in parallel. The generating is performed by two "Castle" dynamo machines driven by a pair of 130 H.P. horizontal engines, by Messrs. R. Hornsby and Sons, of Grantham.

Messrs. Benton and Stone.—Having been recently burnt out of their premises in St. Paul's Square, Birmingham, Messrs. Benton and Stone have now concentrated the whole of their business at their extensive new buildings at Aston Brook. These include foundry tube works, shops in which are constructed all kinds of artistic metal work, and a fine range of show rooms and offices.

C. Carr.—This firm has secured the contract to re-hang the magnificent old peal of eight bells (tenor 1 ton weight) at the St. Thomas's Church, Stonebridge, in competition with all the leading firms of bell founders in the country.

CITY NOTES.

Blackpool Electric Tramway Company, Limited.

THE seventh annual general meeting of the shareholders of the Blackpool Electric Tramway Company, Limited, was held in the Victoria Schools, Tyldesley Road, Blackpool, on Saturday afternoon last. The business of the meeting was unusually brief, at least, that portion of it open to the Press, principally by reason of the fact that the question was to be considered in private, of the lapse of the lease which the company holds under the Blackpool Corporation. The lease was one of seven years' limit, and expires during the ensuing 12 months, under an agreement made between the company and the corporation at the time permission was given by the latter body for the putting down of the lines along the front promenade of the town in 1885. Ever since the agreement was made, the company have considered that they have got hold of the wrong end of the bargain, and have several times attempted to obtain the consent of the august body of rulers to relax one or more of the stringent conditions upon which they are held, but all to no avail. Then, again, deputations have waited upon the corporation to endeavour to come to some understanding as to whether the latter are intending to take over the powers of the company; but the negotiations have never led to anything definite, and matters stand where they did at the outset. And this was the position of affairs which the shareholders were called upon to consider.

Mr. Alderman Richard Horsfall, J.P., C.E., F.S.I., the chairman of the directorate, presided, and there were also present: Mr. Alex. J. Bickerstaffe, ex-Mayor of Blackpool; Mr. Jas. Broadbent, Mr. T. H. Morriss, J.P., Mr. John Oddie, and Mr. Theodore Ormerod, directors.

The balance sheet and report showed an available balance of £3,049 2s. 6½d. for the year's working, but altogether, with £184 17s. 7½d., carried forward from last year, the total sum realisable was £3,234 0s. 2d., of which the directors proposed the following distribution:—£1,501 17s. 6d. as dividend of 7½ per cent. on the called up share capital, free of tax; £1,500 to the depreciation and reserve fund, making it £6,069 4s. 8d.; and a balance of £232 2s. 8d. to next year's account. The report showed that the number of passengers carried during the year was 933,652, and the number of miles run about 98,000. The services of Mr. Broadbent, as managing director, have again been secured for the ensuing year.

In moving the adoption of the report and balance sheet, which showed the capital of the company to stand at £20,025 (2,850 shares at £10 each, £6 10s. called up, £18,525; and 150 shares, £10 each, allotted as fully paid up, to Mr. M. Holroyd Smith, the patentee, under his agreement, £1,500).

The CHAIRMAN remarked that he had not much to say to the shareholders. The company had worked very nicely during the past year, and everything was satisfactory, both in regard to their finances, the works, and everything else connected with them. There was only one item in the balance-sheet which had increased to any appreciable extent, and that was the wages, which was mainly owing to the difficulties they had had to contend with in the accumulation of the sand on the lines at the southerly end of the town. During heavy winds—which had been most frequent during the year—the sand from the foreshore drove up the sea embankment, and literally filled the centre channel of the lines, thus making the service absolutely unworkable at times at the extreme south. That trouble was annually increasing in strength, and something would have to be done to effectually put an end to the nuisance. Referring to the difficulty that is now at issue between the company and the corporation, the Chairman asked the shareholders to stay behind at the close of the ordinary and routine business in order to discuss the matter. Some important correspondence had taken place, he said, between the contending

parties with respect to the renewal or termination of the lease, but he was not at liberty personally to make it a matter of public notoriety. The Chairman concluded by moving the adoption of the report and balance-sheet.

Mr. HOYLE (addressing the Chairman): Do say a few words about the prosperity of the company.

The CHAIRMAN: I think the balance-sheet is sufficient testimony as to our position.

Mr. HOYLE: Yes; but you ought to praise it up as much as you can.

The proposal to adopt the report and balance-sheet was seconded by Mr. MORRIS, and carried unanimously.

The next business before the meeting was the election of directors. The retiring members of the board were Messrs. Horsfall, Bickerstaffe, and Broadbent, and each offered himself for re-election.

The re-appointment of these gentlemen was proposed by Mr. HOYLE, a gentleman interested in several of the most important of the public companies of Blackpool. At the outset he stated that he moved the re-election of the gentlemen in question, as he thought they could not be improved upon. They were now well versed in electricity, and all matters appertaining to the working of the company, and he thought it would be an unwise policy to displace them with men not so competent to deal with their affairs. They had all had to learn something or other about electricity, and there was nothing like being without dividend to make them learn. He acquired all his knowledge about the science in the year they paid no dividend, and a great many of them began to study it at the same time. It was now taught, however, in many of their schools, and their streets, houses, and shops were beginning to be lighted by means of the brilliant illuminant. He could not refrain from referring to the question of the lease. He saw from the Bill which the corporation were promoting in the ensuing session of Parliament that that body were seeking to obtain, amongst other things, any powers which might be deemed expedient to enable them to take over the works of the Blackpool Electric Tramway Company, Limited. He thought, however, that the corporation had powers enough—it had been a one-sided bargain right from the very first, and he fancied that they would all be unanimous in opposing the granting of further powers to the corporation in any shape or form. Two deputations had waited upon similar representatives from the corporation with regard to the widening of one of the piers with which he was connected, and when everything appeared to be settled the corporation stepped in, and all was unsettled. That corporation seemed to him to consist of a sort of "brotherly love"—a secret society—and "the brotherly love" lot went up to London and threw away from £600 to £700 in needless expense, and they would do the same thing again with the Electric Tramway Company if they did not mind.

Mr. BARCROFT seconded the motion, which was then carried.

The CHAIRMAN thanked the shareholders on behalf of himself and his colleagues for the confidence they had reposed in them, and at the same time expressed their thanks to Mr. Hoyle for the words of advice and caution he had given utterance to.

Mr. J. D. Taylor, of Halifax, was the retiring auditor, but he was re-elected on the proposition of the CHAIRMAN, seconded by Mr. HOYLE.

This concluded the business open to the Press, the shareholders remaining behind to discuss the matter privately, as mentioned above.

Swan United Electric Light Company.

THE ninth ordinary general meeting of the shareholders of the Swan United Electric Light Company, Limited, was held on Tuesday last at Cannon Street Hotel, Mr. James S. Forbes (the chairman) presiding.

The CHAIRMAN said: I will now proceed to make a few remarks upon the report and accounts, and, probably, the most convenient method is to deal with the figures first, before going into the more general questions. The material thing in these yearly accounts is to ascertain the result of the working of the year, and that will be found in the profit and loss account, which is, in fact, the trading account for the year. It is very short, simple, and easily comprehended. If you follow me through the debtor and creditor sides of the account, I think you will be able to appreciate very clearly the position of the undertaking as a going concern for the past year. The first entry on the debtor side is the stock on October 1st, 1890, £11,124. Then come the purchases, which means the materials—and in some cases the finished articles—necessary for carrying on our business. Next comes the general administration of the company—salaries, directors' fees, rent, office expenses, income tax, general and law charges, &c. Then we have wages and expenses at the factory—over and above the cost of purchase of materials, the cost of turning those materials into a saleable commodity. We next have the depreciation, and then the balance. On the other side of the account the sales, less commissions and allowances, come to £15,348; transfer fees and interest, £1,290; dividend on shares in La Compagnie Générale des Lampes Incandescentes, £1,178; dividends on shares in the Edison and Swan United Electric Light, £34,799; and the stock with which we closed up the year, £18,449. Well, dealing with the credit side of the account, as representing what may be called the solid asset, and dealing with the other side of the account, as representing the cost of every asset, you will see that the balance is £39,038. Of course, you will observe at once that a very large part of that £39,000 profit is derived from the investments of your company in the Edison and Swan United Electric Light Company, Limited—£34,799 out of the £39,038. I will now give you some details, and to do that I will take you to the balance-sheet. The share capital—some of which is fully paid and some partially paid—amounts to £375,071. The forfeited shares amount to £3,530, that being the amount paid upon allotment and upon some proportion of the calls by people who later on failed to pay up calls when made. Those shares were in due course, and after proper notice to the parties, forfeited; in fact, they are, for what they are worth, an asset of the company. The sundry creditors stand at £4,642; the balance from previous account, because last year we did not divide up to the hilt, to £8,451, and the balance brought down comes to £39,038, which makes the sum available for distribution, or, at all events, for dealing with, £47,490. In this company, as in other companies, we have an annual balance sheet and an annual distribution; but it has become the fashion to pay what is called an interim dividend. We have done it now for a year or two, and we, on account of this year, paid £11,104 on May 21st. That, you see, deducted from the £47,490, leaves £36,386 to be dealt with to-day. On the other side of the account you get a very simple statement of the position of the company. You will see that for cost of patent rights, &c., represented by shares in the Edison and Swan Company, Limited, shares in La Compagnie Générale des Lampes Incandescentes, and patents held by the company for Germany, &c., as per last balance sheet, we have written down the primitive cost, viz., £330,837, and the capital of the company paid up is £375,000. The additional expenditure with regard to patents, subject to readjustment between the two companies, amounts to £1,612, which brings the total amount of cost of patents up to £332,499. The outlay on factories, less depreciation, amounts to £1,570; but I need hardly say that the actual outlay has much exceeded that amount, because you cannot establish a factory calculated to turn out any considerable number of lamps for anything like £1,500. That amount is so low, because for some years we have written off 20 per cent. out of revenue on account of the money expended. The sundry debtors amount to £6,545, which you will see exceeds the corresponding item of sundry creditors by nearly £1,000; the stock on hand stands at £18,449, while investments in Prussian Consols amount to £5,120, the investments in New Two-and-Three-Quarter per Cent. Consols to £29,004, and cash on deposit and in hand to £26,490. Now, first of all, what are you going to do with this £36,386 10s. 9d.? What the directors will recommend you to do they have set forth in the report. They tell you that out of that balance they have already paid you £11,004 in dividends, and they recommend that the dividend for the year should be at the rate of 11 per cent., which will leave £28,376 6s. 11d. to be paid, and also leave £8,010 to be carried forward for the benefit of the current year, which is within £450 of the amount we brought forward last year. That seems a recommendation entirely justified by the state of the balance-sheet, and I think you will agree that in the present position of the company it is prudent not to divide up to the hilt. If you can pay 11 per cent. and carry forward about the same balance as you brought forward last year it is not so bad, particularly when you consider our stock. It is perfectly clear that these lamp companies cannot conduct their business satisfactorily without having in hand a very large amount of stock. The lamps, although they are generally described as 16 candle-power or 8 candle-power, or some other quantity, greatly vary—in fact, in many particulars they are outside what may be called the rut of the business. A great many lamps are made to special order, which involves a great many types and subdivisions, and although that is a disadvantage in one sense, it is an advantage in another. A great business cannot be done without a great stock, and a great stock means a large amount of money locked up. We have £18,000 in stock, and, perhaps, by-and-bye, a large stock may turn out to be an advantage to big companies who have had protection, or, at all events, a start for a term of years, and thereby have made a reputation and a *clientèle*, from the fact that they are able to turn out very large quantities of lamps at a price at which a small man could not possibly live. Of course, if we had come to the end of our business to-day, and were going to realise our assets, that stock, if sold at a moderate profit, would be so much to the good, as the stock of lamps appeared in the accounts at cost price. Therefore, what you are dealing with is an ascertained, humanly speaking, absolute profit of 11 per cent., with £8,000 carried forward from the previous year, and a contingent value lying dormant in your concern for realisation during the current and future years. That is the basis of the whole thing. I do not propose to go into any of the details of these various figures, except in the way of answering questions. I will now come to something a little more general. The most satisfactory part of this report is the paragraph which tells you that "the decision of the Supreme Court at Leipzic, in the patent cases which the Allgemeine Electricitäts Gesellschaft brought against the company and their agents has been given in favour of the company." Well, that is a matter of great moment. The question in dispute was exactly the same as that in dispute in England, when, I think, some of the gentlemen sitting at this table, in their wisdom, induced the Edison and Swan Company to put their horses together instead of cutting each other's throats. Oddly enough, in Germany, those representing the Edison Company and those representing the Swan Company have not been able to follow so wise an example, with the result that they had been in litigation several years, the Swan Company having been brought to book by the Edison Company as infringers of the Edison patent. We never raised that question in this country. It is not for the want of trying on our part that this state of things has continued in Germany. We have tried to persuade our friends that what has turned out to be so good in England may be good in Germany, but hitherto they have not seen it. The result of the litigation, however, is that we have on final appeal, after protracted proceedings, which will equal anything which we know in the law courts in England as illustrating the law's delay, succeeded. The Swan lamp, therefore, as we manufacture it, has been declared to be no infringement of the Edison patent, and we are free now to go our way without challenge, and without being denounced in advertisement and in conversation as infringers, and without our customers being threatened with damages in the event of our being found guilty. You

will see that that decision places the German business in an entirely different position. We go on in the paragraph to say: "The directors are now engaged in the consideration of the best way to take advantage of the favourable position thus created in Germany." Well, it is the difference between working in freedom and working in chains, and although the nature of the German law to put penalties upon people who are wrongdoers in the dark, as it were, without knowledge, is generally very light; yet when they have been warned for wrong-doing by legal notice, if they pursue the wrong course they stand to be pretty heavily salted. This has been our position for several years, and although we went on making Swan lamps, we had always before us a fear of penal damages. During the last year or two we have learned a little by litigation, but yet were fearful that some abstruse points might turn against us; therefore we held our hands, and did not push our business as it might be pushed, and as we certainly shall push it now. The next paragraph in the report refers to our investment in Paris shares, and here the same protracted litigation is going on as to this patent; but I suppose by the time they run out some decision will be come to. That company is not doing so very well, for the reason that they are in litigation, and that everybody during that litigation can make lamps and send them into France, and there is what they call a cutting of rates going on. Still, it is possible that that state of things may terminate sooner or later, and I suppose the French companies will come to an understanding, because, of course, there is no particular object in men giving their brains and money to manufacture things and sell them at a price which gives no profit. That brings me to the end of this report, but I must make this observation: The Swan Company have now got into a big position. We have divested ourselves of any care or trouble about the working of our patents, and we did that in virtue of 208,478 shares or capital we hold in the Edison and Swan United. I do not know whether honourable proprietors appreciate that this company is doing very well, and that, in all probability, it may in the future be well off. Like other companies, they have got to face a different state of things when the protected period runs out. That we have foreseen, and we have laid our plans and shaped our policy upon this: that we must "make hay while the sun shines"—that is to say, we must make the best lamp, get the best *clientèle*, and establish the best reputation, and at the end of that time, with ample means and good connections, we must take our chance with other people. If this policy be justified by the result, we shall find ourselves in a position to make as good a lamp as can be made, probably better than most lamps. We shall then find ourselves in a position of having a great number of customers who, having a knowledge of our lamp, will not be tempted to change; and, with the capital we have in hand, we shall be enabled to produce this lamp at a price as low as, or lower than, other people can, and, therefore, shall be able to sell at a low price with a profit; in fact, it means a small profit on a large quantity instead of a large profit on a small quantity, and you will participate in that to the extent of £208,478. You are the largest shareholders in the United Company. Our lamp business in France we parted with for £30,489, and I have told you what their position is. The only other thing I need refer to is the German business, which may be a more or less important business. Now that the litigation is settled, it is just worthy of consideration whether it is worth while having that portion of the business administered for us there by the Edison and Swan or the French company, or whether it is worth while keeping up a separate company or a separate staff for that purpose. You know we said before, when the litigation was over and we saw our way, that it would be a prudent thing to consider whether the Edison and Swan Company in England might not absorb, on fair and reasonable terms, the outlying business and assets generally of the Swan Company. They have a considerable amount of money and assets in hand, which would be utilised by the Edison and Swan just as well as by the Swan Company as a separate administration. We may be prepared at some early date to consult the proprietors on details. Although the Edison and Swan Company are a united body, they consist of two parts, and although in Britain they have an absolute identity and interest, in a question of buying and selling a new business they might not. We have upon our board those who were imported into the happy family from the Edison, and they represent themselves and their co-partners in the Edison Company. We have also connected with our board gentlemen who hold largely for themselves, and represent wholly the interest of the Swan Company, and we think it prudent to ask two of those gentlemen on either side to meet and consider this question of fusing the existing Swan Company, or, rather, taking over the assets and outstanding business not already provided for by the Swan Company upon some terms which may be acceptable to the proprietors of both companies. It is in very good hands, and I do not think that we shall wait very long before some reasonable conclusion is arrived at. We think that the time has gone by when it is necessary to carry on the Swan as a separate company largely for the sake of conducting the German business, and I hope that idea will commend itself to the proprietors. I now beg to move: "That the report and accounts for the year ending September 30th, 1891, be received and adopted."

Mr. F. R. LEYLAND seconded the motion, which was carried unanimously.

After the re-election of Mr. J. W. Swan as a director of the company, and the re-election of the auditors, a vote of thanks was accorded to the chairman and board.

The Allgemeine Electricitäts Gesellschaft.

THE eighth annual report and balance sheet of the Allgemeine Electricitäts Gesellschaft, of Berlin, which has just been published, is one of the most interesting documents of the kind ever brought to our notice. We have in previous years referred to the remarkable developments of this great industrial enterprise, and we are pleased to note again some of the principal items in this excellent report. The company, it will be observed, is not only a great manufacturing concern, employing upwards of 1,500 hands, but it also invests large sums of money in a variety of electrical undertakings, most of which, in turn, are important customers of the parent concern. Among other enterprises this company is interested in the Berlin central stations to the extent of 2,148,513 marks; in the central stations of Traben-Trarbach 10,000 marks; Eisenach 200,000; the Compagnia Madrilena de Electricidat, of Madrid, 1,141,025 marks; the Keys' Electric Company, of London, 217,398; the brass foundry of Spinn and Son, 690,437; the Accumulator Works at Hagen, 208,000; the Compagnie International d'Electricite of Liege, 368,725; the Edison General Electric Company of New York, 2,617,666; and in tramway companies the sum of 2,302,850 marks. The Allgemeine Elektricitäts Gesellschaft has now an accumulated reserve fund of 4,479,479 marks, although its nominal capital is but 20,000,000 marks, or about one million pounds. The net profits of last year were 2,236,563 marks, of which 1,800,000 or 9 per cent. on the capital were distributed among the shareholders, 180,000 went into director's fees and bonuses, 90,000 to the pension fund of the staff, and the remainder carried forward to next year's account.

Out of profits the company has last year considerably augumented its plant, tools, and buildings. The output of incandescent lamps made by the A.E.G. is now one million per annum and it has facilities for doubling this number of lamps, if the demand arises. The value of patents is again credited with one shilling in the balance sheet, although thousands have been spent last year for new inventions and on patent fees.

In addition to several new types of dynamos a series of different sizes of electric motors have been developed during the past twelve months. The greatest activity has been displayed by the Allgemeine Elektricitäts Gesellschaft in the production of the Multiphase System of Electric Transmission of Power, which was exemplified with so much well-deserved success in the Lauffen-Frankfurt installation. On the strength of this alone, some of our English companies would have been tempted to raise any amount of additional capital or debentures. The successful working of the Halle Electric Tramway, with its 25 cars and overhead conductors, constructed by the A. E. G. last spring, marks a new departure in Germany, and already contracts for several similarly arranged lines have been accepted. A concession has been obtained for utilising waterfalls on the Rhine, aggregating 12,000 H.P., which will soon be transmitted electrically to important industrial centres in Germany.

The Allgemeine Elektricitäts Gesellschaft has not only given another proof of its wonderful commercial and manufacturing abilities, but it has taken the lead in the van of electrical progress, as has been amply demonstrated in the Lauffen experiments, as well as in many other improvements which, though not so well known to the public, are nevertheless important.

The Venezuela Telephone and Electrical Fittings Company, Limited.

ACCORDING to the *Financial Times*, the report recently issued by the directors of this company shows a most remarkable rate of progress. The number of subscribers is increasing so rapidly that at Caracas the switchboard of 2,000 capacity has had to be discarded and a fresh one of double that capacity constructed. At the beginning of 1891 there were, including applicants, 1,400 subscribers; on October 17th the number actually connected was 1,832. The general manager, in a report on the progress of the company, estimates for the current year an increase of 20 subscribers per month at Caracas and La Guaira, and takes the figures for Valencia and Puerto Cabello at the same as last year. His estimate for the first month of the year has been largely exceeded, but assuming it to be maintained on the average, the gross earnings would be £18,350, against £16,253. If two-thirds of this gross gain were secured to the shareholders, it would allow of an addition of one and a-half per cent. to the dividend, making it 5 per cent.

At the first ordinary general meeting of the company a dividend at the rate of 4 per cent. per annum was declared on the shares of the company for the half-year ended June 30th.

The Western and Brazilian Telegraph Company, Limited.—The Western and Brazilian Telegraph Company, Limited, on Tuesday last, received information that the Fiscals have been removed from all the offices in Brazil and that there are now no restrictions on telegrams to and from that country.

Direct Spanish Telegraph Company.— During the temporary interruption of the Direct Spanish-Falmouth-Bilbao cable, arrangements have been made by which telegrams for Bilbao, Madrid, and all places in Spain can, during the interruption, be promptly forwarded by the Eastern Telegraph Company's route.

Eastern Telegraph Company, Limited.—The Eastern Telegraph Company, Limited, state that all restriction to telegraphic communication with Brazil is now removed.

TRAFFIC RECEIPTS.

The City and South London Railway Company. Traffic receipts for the past week amounted to £792.

SHARE LIST OF ELECTRICAL COMPANIES.

Present Amount Issued.	Name.	Stock or Share.	Closing Quotation. (Nov. 19th.)	Closing Quotation. (Nov. 26th.)	Business done during week ending (Nov. 26th, 1891.) Highest.	Lowest.
250,000*l*	African Direct Telegraph, Ltd., 4 p. c., Deb. Regd. and to Bearer	100	100 —103	100 —103	...	...
1,300,980*l*	Anglo-American Telegraph, Limited	Stock	48½— 49½	48½— 49½	49⅝	...
2,849,510*l*	Do. do. 6 p. c. Preferred	Stock	86½— 87½	86½— 87½	87⅝	86⅜
2,849,510*l*	Do. do. Deferred	Stock	12 — 12½	12 — 12½	12¼	12
130,000*l*	Brazilian Submarine Telegraph, Limited	10	10 — 10½	10½— 11	11	10½
53,200*l*	Do. do. 5 p. c. Bonds	100	100 —103	100 —103	100¼	...
75,000*l*	Do. do. 5 p. c., 2nd Series, repayable in June, 1906 ...	100	103 —107	103 —107	...	...
77,978*l*	Brush Electrical Engineering Ordinary, Nos. 1 to 63,416	3	3⅜— 3⅝	3⅜— 3⅝	3½	3⅜
69,996*l*	Do. do. Non cum. 6 p. c. Preference, Nos. 1 to 63,416	2	2⅛— 2⅜	2⅛— 2⅜	2 5/16	2⅛
50,000*l*	City and South London Railway, Nos. 1 to 50,000	10	3 — 5	3 — 5	3½	...
30,152*l*	City of London Elec. Lighting Co., Ltd., Ord. 40,001-70,152, £4 paid	...	...	3¾— 4¼	4 1/16	4
$7,716,000	Commercial Cable, Capital Stock	$100	140 —145	140 —145	145	144
224,850*l*	Consolidated Telephone Construction and Maintenance, Limited ..	14/-	7/16— 9/16	7/16— 9/16	...	...
20,000*l*	Crompton & Co., Ltd, 7 p. c. Preference Shares, Nos. 1 to 20,000	Stock	5 — 5½	5 — 5½	...	...
16,000*l*	Cuba Telegraph, Limited	10	10 — 11	10 — 11	...	...
6,000*l*	Do. do. 10 p. c. Preference	10	16 — 17	16 — 17	...	...
12,931*l*	Direct Spanish Telegraph, Limited, ... (£4 only paid)	5	3 — 3½	3 — 3½	3⅜	...
6,000	Do. do. 10 p. c. Preference	5	9½— 10½	9½— 10½	...	...
60,710	Direct United States Cable, Limited, 1877	20	10⅝— 11	10⅝— 11	11	10⅝
400,000	Eastern Telegraph, Limited, Nos. 1 to 400,000	10	13⅞— 14⅛	14 — 14⅛	14⅛	14
70,000	Do. 6 p. c. Preference	10	14⅜— 15¼	14⅜— 15¼	15	...
200,000*l*	Do. 5 p. c. Debs. (1879 issue), repay. August, 1899	100	107 —110	107 —110	108	...
1,200,000*l*	Do. 4 p. c. Mortgage Debenture Stock	Stock	106 — 109	106 — 109	108	106½
250,000	Eastern Extension, Australasia and China Telegraph, Limited ...	10	14¾— 15	14⅞— 15⅛	15⅛	14⅞
78,300*l*	Do. 5 p. c. (Aus. Gov. Sub.), Deb., 1900, red. ann. drgs. reg. 1 to 1,049, 3,976 to 4,326	100	104 —107	104 —107	...	...
276,200*l*	Do. do. Bearer Nos. 1050—3,975 and 4,327—6,400 ...	100	104 —107	104 —107	...	...
320,000*l*	Do. 4 p. c. Debenture Stock	Stock	106 —109	107 —110	108	...
135,000*l*	Eastern and South African Telegraph, Ltd., 5 p. c. Mort. Deb. 1900 redeem. ann. drawings, Registered Nos. 1 to 2,343	100	102 —105	102 —105	105	...
180,400*l*	Do. do. do. to bearer, Nos. 2,344 to 5,500	...	102 —105	102 —105	104	...
201,600*l*	Do. do. 4 p. c. Mort. Debs. Nos. 1 to 2016, red. 1909	100	98 —101	98 —101	...	...
45,000	Electric Construction, Limited, Nos. 101 to 45,100	10	6⅞— 7¼	6½— 7	7⅛	6⅞
19,900	*Electricity Supply Co. of Spain, Nos. 101 to 20,000	5	... ...	... ...	...	...
66,750	Elmore's French Patent Copper Depositing Co., Ltd, Nos. 1 to 66,750	2	1⅞— 2⅛	2 — 2¼	2¼	1 5/16
70,000	Elmore's Patent Copper Depositing, Limited., Nos. 1 to 70,000 ...	2	2⅛— 3⅛	2⅞— 3⅛	3¼	2⅝
67,385	Elmore's Wire Mfg., Ltd., Nos. 1 to 67,385, issued at 1 p.m., all pd	2	1⅛— 1⅞	1⅛— 1⅞	1⅛	...
20,000	Fowler-Waring Cables, Nos. 301 to 20,300 ... (£4 10s. only paid)	5	2 — 3	2 — 3	...	...
180,227	Globe Telegraph and Trust, Limited	10	9⅝— 9⅞	9⅝— 9⅞	9⅞	9 1/16
180,042	Do. do. 6 p. c. Preference	10	14⅜— 14⅝	14⅜— 14⅝	14⅝	14 7/16
150,000	Great Northern Tel. Company of Copenhagen	10	18½— 18⅝	18½— 19	18⅝	18¼
220,000*l*	Do. do. 5 p. c. Debs. (issue of 1883) ...	100	105 —108	105 —108	...	...
12,134*l*	Greenwood and Batley, Ltd., Ordinary, Nos. 4667 to 14,000 ...	10	8 — 8½	8 — 8½	...	...
9,600*l*	Do. 7 p. c. Cumulative Preference, Nos. 2,667 to 8,000	10	9½— 10½	9½— 10½	...	...
41,600	India-Rubber, Gutta Percha and Telegraph Works, Limited ...	10	20½— 21½	20½— 21½	21⅜	21
200,000*l*	Do. do. 4½ p. c., Deb., 1896	100	102 —104	102 —104	...	...
17,000	Indo-European Telegraph, Limited	25	41 — 43	41 — 43	42¼	...
11,334	International Okonite, Ltd., Ordinary Nos. 22,667 to 34,000	10	6 — 7	6 — 7	...	...
11,334	Do. do. Preference Nos. 5,667 to 17,000 ...	10	8⅜— 9½	8⅜— 9½	...	...
38,348	London Platino-Brazilian Telegraph, Limited	10	6 — 7 xd	6 — 7	...	...
100,000*l*	Do. do. do. 6 p. c. Debentures	100	105 —108	105 —108	...	...
43,900	*Metropolitan Electric Supply, Ltd., Nos. 6,101 to 50,000 (£9 paid)	10	10 — 10½	10 — 10½	10 5/16	10⅛
447,234*l*	National Telephone, Limited, Nos. 1. to 438,984	5	4⅜— 4⅝	4⅜— 4⅝	4⅝	4⅜
15,000	Do. 6 p. c. Cum., 1st Preference	10	12½— 13	12½— 13	...	...
15,000	Do. 6. p. c. Cum. 2nd Preference	10	12 — 13	12 — 13	...	...
420,000*l*	Do. 4½ p.c. Deb. Stock Prov. Certs. fully paid ...	...	106 —108	107 —109	108⅜	107½
250,000*l*	Do. (issued at 5 p.m., all paid)	...	...	28 — 32	...	...
6,318*l*	Notting Hill Electric Lighting Company, Limited, £8 paid ...	10	6 — 7	6 — 7	...	...
220,000*l*	Oriental Telephone, Ltd., Nos. 80,001 to 300,000 (11s. only paid)	1	3/16 — 5/16	3/16 — 5/16	...	...
9,000*l*	Reuter's Limited	8	7⅞— 8¼	7⅞— 8¼	...	...
18,680	St. James's & Pall Mall Electric Light Co., Ltd., Ord., 101—18,780	5	8⅞— 9¼	8⅞— 9¼	9¼	9
7,900	Do. do. do. 7 per cent. pref.	2	7¼ — 7¾	7¼— 7¾	7¾	...
3,381	Submarine Cables Trust	Cert.	117 —122	117 —122	117½	...
78,949	Swan United Electric Light, Limited ... ... (£3½ only paid)	5	4½— 4⅝	4½— 5	4⅝	4 9/16
37,350	Telegraph Construction and Maintenance, Limited	12	42 — 44	42 — 44	43½	42½
150,000*l*	Do. do. do. 5 p. c. Bonds, red. 1894	100	102 —105	102 —105	...	...
58,000	United River Plate Telephone, Limited	5	1 — 2	1 — 2	...	...
146,370*l*	Do. do. 5 p. c. Debenture Stock ...	Stock	85 — 95	85 — 95	...	...
3,200*l*	Do. do. 7 p. c. Debs., Nos. 1 to 1,000 ...	100	... ...	... ...	...	...
15,609	West African Telegraph, Limited, Nos. 7,501 to 23,109	10	7½— 8½	7½— 8½	...	...
271,400*l*	Do. do. do. 5 p. c. Debentures, ...	100	96 — 99	96 — 99	...	...
30,000	West Coast of America Telegraph, Limited	10	2½— 3½	3 — 4	4	2 5/16
150,000*l*	Do. do. do. 8 p. c. Debs., repayable 1902 ...	100	97 — 102	97 —102	...	...
67,007*l*	Western and Brazilian Telegraph, Limited	15	9⅜— 10½	10 — 10½	10½	9⅝
30,364*l*	Do. do. do. 5 p. c. Cum. Preferred	7½	6¾— 6⅞	6¾— 7	6⅞	...
30,364*l*	Do. do. do. 5 p. c. Deferred	7½	3¾— 4	3⅝— 4¼	4	3 11/16
189,700*l*	Do. do. do. 6 p. c. Debentures "A," 1910 ...	100	104 —107	103 —106	...	...
237,200*l*	Do. 6 p. c. Mort. Debs., series "B" of '80, red. Feb., 1910	100	103 —106	103 —106	...	...
88,321	West India and Panama Telegraph, Limited	10	1½— 1⅝	1½— 1⅝	1½	...
34,563	Do. do. do. 6 p. c. 1st Preference ...	10	8⅞— 9½	9 — 9½	...	...
4,669	Do. do. do. 6 p. c. 2nd Preference ...	10	7½— 8½	7½— 8½	7½	...
$1,336,000	Western Union of U.S. Tel., 7 p. c. 1st Mortgage (Building) Bonds	$1,000	118 —122	118 —122	121½	...
173,100*l*	Do. do. 6 p. c. Sterling Bonds	100	98 —102	98 —102	...	...
59,900	*Westminster Electric Supply Corp., Ord., Nos. 101 to 42,953 ...	5	6¼— 6½	6¼— 6⅝	6 9/16	6 5/16

* Subject to Founders' Shares.

LATEST PROCURABLE QUOTATIONS OF SECURITIES NOT OFFICIALLY QUOTED.

Blackpool Electric Tramway Company, Limited, £10 (£6½ paid) 7¼—7⅞.—City of London Electric Lighting Company, Ordinary Shares of £10 each, £4 paid, 4⅛—4⅜.—Electric and General Investment, Shares of £5, £1 paid, 2⅜—3¼.—Elmore's Austrian Copper Depositing, 15s., 25s., £2 share issued at 10s. prem. fully paid, 1—1½.—Elmore's Priorities, 3⅛—4⅛.—European Sims-Edison Torpedo Company, shares of £20, fully paid, 20—20½.—Halifax and Bermuda Cable, 4½ per cent. bonds, 85—95.—House to House Company (£5 paid) 4¼—5.—Liverpool Electric Supply, Shares of £5, £3 paid, 2⅜—2⅝. Shares of £5 (fully paid), 4⅞—5⅛.—London Electric Supply Corporation, Ordinary (£5 paid), 1⅜—2⅛.—Manchester, Edison and Swan Company, £9 (£1 paid), ⅛—⅜.—National Telephone Debentures, 2½—3 prem.—Woodhouse and Rawson Ordinary of £5 (£2 10s. paid), 2⅛—2⅜.—£5 Preference, fully paid 3⅛—3⅞.—Debentures, 90—95.—Wards Electric Car, £10 paid, ⅜—1.

BANK RATE OF DISCOUNT.—4 per cent. (October 29th, 1891).

PROCEEDINGS OF SOCIETIES.

The Institution of Electrical Engineers.

AT the ordinary general meeting last Thursday week, "the usual preliminary business was agreeably diversified. The president announced that the Council had elected Mr. Jacob Brett an honorary member of the Institution, in recognition of his valuable services in connection with the introduction of submarine telegraphy. He also announced two very interesting donations, viz; an excellent portrait in oils of Mr. Jacob Brett, painted and presented by Miss Alice Bolton, of 49, Blomfield Road, Maida Vale, and seven volumes of manuscript letters and manuscripts formerly belonging to the late Sir William Fothergill Cooke, relating to the introduction into England of the electric telegraph by himself and his partner, the late Sir Charles Wheatstone, presented by Mr. Latimer Clark, past president.

Mr. CLARK, in acknowledging the vote of thanks to himself, and in seconding a similar vote to Miss Bolton, made some most interesting remarks on the subject of Mr. Brett's connection with the introduction of telegraphy, remarking that comparatively few appeared to know how intimate that connection was. He also alluded to the extremely interesting character of the Cooke MSS. which he had the pleasure of presenting to the Institution, and in support of his remarks, quoted some of the earlier letters written by Cooke when at Heidelberg."

DESCRIPTION OF THE STANDARD VOLT AND AMPEREMETER USED AT THE FERRY WORKS, THAMES DITTON.* By Captain H. R. SANKEY (late R.E.), Member, and F. V. ANDERSEN, Associate.

1.—INTRODUCTION.

It is well known to many electricians that Messrs. Willans and Robinson have established at their works at Thames Ditton a complete arrangement for measuring accurately the steam consumption of their engines. To obtain the efficiency of combined sets of engines and dynamos, measurements must, of course, also be made of the electric current and pressure, and it was found that even the best ammeters and voltmeters in the market could not be relied upon to give the same degree of accuracy as was obtained in the steam-consumption measurements. Moreover, all such instruments laboured under the disadvantage that they were calibrated elsewhere, so that the results were dependent upon other people's measurements to a degree which was thought to be undesirable.

After a series of investigations—commenced as early as 1887—into the question of the class of apparatus which would be most likely to give satisfactory results under the special circumstances, a scheme was drawn up in 1889 for a complete apparatus for measuring currents, differences of potential, and resistances, and the various instruments were designed and ordered. It was not, however, until the beginning of the present year that time and opportunity were found to have the apparatus put to practical use, various additions and improvements being introduced as the work proceeded.

As will be seen in the sequel, no new principles have been introduced in electrical measurements with the present apparatus. It was thought, however, that a complete set of workshop instruments fulfilling the conditions for high accuracy, and yet possessing the simplicity required for everyday use in an engineer's shop, would be found of sufficient interest to electrical engineers to justify a short account of it being brought before the Institution.

The more important conditions imposed in designing the apparatus were that—

(1.) All measurements made must be capable of verification at any time by a direct comparison of certain resistance coils with a standard ohm, and of a constant potential difference with a standard cell; and that the arrangements should allow of these comparisons being made quickly for the satisfaction of those interested in the accuracy of the measurements.

(2.) Volts and ampères must be indicated by direct deflection on a scale, and no balancing operation be required from the observer by torsion arrangements or otherwise; and the value of the readings must not be influenced by the working of dynamos or the moving of large masses of iron within a few yards' distance.

(3.) The ammeter as well as the voltmeter must be left in circuit permanently during trials of any desired length.

(4.) The errors to which the measurements are liable should not exceed $\frac{1}{2}$th per cent.

(5.) The range such as to allow of measurements being made of pressure from $\frac{1}{1000}$th part of a volt to 700 volts, and of current from $\frac{1}{10}$th of an ampère to 1,100 ampères.

2.—APPARATUS REQUIRED.

The complete apparatus comprises the following:—

I.—*For measuring ampères:*

1 D'Arsonval galvanometer.
1 high-resistance box, adjustable by the unit, for use in series with galvanometer.
1 rheostat of platinoid strips for carrying the main current.

II.—*For measuring volts:*

1 D'Arsonval galvanometer,
1 high-resistance box, adjustable as above, for use in series with galvanometer. A Wheatstone bridge box is used for this purpose.
3 potentiometer rheostats, 250 ohms each, made of platinoid wire on screwed slate rods, carrying capacity up to 1 ampère.

III.—*For calibration.*

1 Clark standard cell containing two elements.
1 standard ohm.
1 standard rheostat of 5 platinoid strips, arranged for coupling in parallel or series, each strip capable of carrying 10 ampères.
1 mercury rheostat, capacity 50 ampères.
1 secondary battery, 3 large cells (15L E.P.S.)
1 key with double set of contacts, for use with standard cell.
1 resistance coil, 10,000 ohms, for use with same.
2 $\frac{1}{9}$ shunts for galvanometers.

IV.—*General.*

Leclanché cells for bridge test, keys, ebonite pillars for connections, &c.

The method of using the apparatus for actual measurements will first be described, after which the calibration of the galvanometers and the verification of the various resistances will be discussed.

3.—MEASURING AMPÈRES.

The apparatus used for this purpose is shown on fig. 4. On the same figure is drawn the voltmeter arrangement, in order to give the general arrangement of the whole set of instruments. It will be seen on fig. 4 that for current measurements the method of measuring the fall of potential across a known resistance has been adopted. The measurement of this resistance—*i.e.*, the

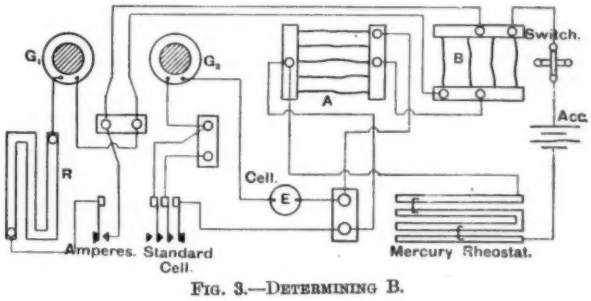


FIG. 3.—DETERMINING B.

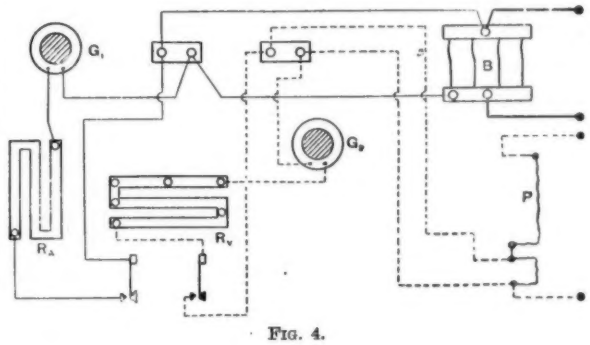


FIG. 4.

resistance of rheostat, B, fig. 3 and fig. 4, which, of course, must be made with great accuracy—could not be taken satisfactorily by a Wheatstone bridge, owing to its small value (about ·001 ohm); the method adopted for this purpose will be described further on.

The scale of the D'Arsonval galvanometer, G_1, has, in addition to the ordinary millimetre scale, another scale graduated to read from 0 to 1,100 ampères, on which the divisions are proportional to the corresponding currents through the galvanometer, the relation or constant connecting the deflections with this current being known from the calibration of the galvanometer.

By modifying the resistance, R, used in series with the galvanometer, the constant of the ammeter can be modified to suit the number of ampères to be measured.

When the main rheostat, B, is made from the same metal and placed in the same room as the resistance box, R, the periodic temperature variations in the atmosphere do not affect the measurements of the current through the increase of the resistances of these two instruments, as the increase in one balances that in the other.

For ordinary work the readings on the scale are amply accurate, as they can be depended upon to be within ·3 per cent. of error.

For very accurate trials, however, the scale is used only to ensure the practical steadiness of the load, and for taking readings at short intervals in order to obtain the mean reading. The current corresponding to this mean reading is then determined by direct comparison with the standard ohm and cell.

This determination of the current is made by substituting in the galvanometer circuit an E.M.F. equal to that of the standard cell for the P.D. on the terminals of B, and then, by shunting the galvanometer and adjusting R, reproducing the deflection in question.

4.—MEASURING VOLTS.

The apparatus for this purpose is shown on fig. 4 in a diagrammatic form. It consists of a D'Arsonval galvanometer, G_2, with a resistance, R, in series, and a rheostat, P, connected with the difference of potential leads—for instance, with the terminals of a dynamo.

The scale of the galvanometer has a second graduation constructed in accordance with a calibration, so as to have its divisions propor-

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* Abstract.

tional to the corresponding currents through the galvanometer. This proportional scale is divided from 0 to 175 volts, and unit deflection on the volt scale is produced by a current through the galvanometer of 1 micro-ampère.

In measuring P.D.'s smaller than 1 volt, the rheostat, P, is not used, but the P.D. to be measured is directly connected into the circuit of G_2.

When measuring P.D.'s higher than 1 volt, the P.D. to be measured is connected across the rheostat P, of which a small section—"a" on fig. 4—is connected with the circuit of G_2. This section "a" is so adjusted as to be exactly $\frac{1}{100}$th part of the total resistance of P + the dynamo leads, which sum is = 250 ohms.

The ratio $\frac{a}{\text{P + leads}}$ is called the potentiometer factor.

When it is required to measure high voltages, a second and even a third rheostat, P_1 and P_2, each of 250 ohms, can be joined in series with P, and so the potentiometer factor altered from $\frac{1}{100}$th to $\frac{1}{200}$th or $\frac{1}{300}$th. Further alterations can, of course, be made in the voltmeter constant by varying the resistance, R, as in the case of the ammeter.

The potentiometer factor is evidently independent of the temperature of the rheostats, P. The temperature correction required in R is simply ·023 per cent. of R* + ·388 per cent. of G per degree C. of variation. It will be seen that for the ordinary ranges the resistance of the galvanometer—about 435 ohms—is very small compared with R, and that therefore the errors in the measurements due to unavoidable small errors in the estimation of the temperature of R are quite insignificant.

The strongest current which at any time will pass through the galvanometer circuit is the current which deflects to the end of the scale, or ·000175 ampères. The heating caused by this current in the galvanometer, as well as in the resistance-box, coils is quite inappreciable, and the galvanometer may therefore be left "on" for any length of time.

For everyday work the scale is used, the readings being well within ·3 per cent. of error. For more accurate work, however, readings are taken at intervals, and the mean reading is afterwards calibrated against the standard cell.

5.—Measuring Resistances.

With the addition of a few Leclanché cells, with key, and a short-circuit key for galvanometer, the apparatus contains everything required for making Wheatstone bridge tests with good accuracy.

Small resistances, such as the resistance of a dynamo armature or of a brush contact, are taken by passing a current through the resistance, reading simultaneously the ampères passing through it and the P.D. at its ends. The following is an example of a test of the resistance of an armature with different strengths of current:—

Ampères through armature.	Volts between brushes.	Resistance in ohms.
25·9	·203	·00784
47·1	·370	·00786

Insulation resistance can be measured in the ordinary way—by the deflections—by means of the E.M.F. of any available dynamo; and as the value of the current through the galvanometer is read direct, the time usually spent in determining the constant of the galvanometer is saved.

Example:

The E.M.F. of a dynamo running excited without load was measured on the voltmeter galvanometer, G_2, in the ordinary way, and found = 103 volts. The circuit from this dynamo was then opened, and again closed by joining one end of it to the shaft, the other end to the commutator of an armature the insulation of which was to be tested. The volts were again read, the insulating material of the dynamo armature thus forming part of the circuit, which was made direct through G_2—the potentiometer rheostat having been disconnected. The reading on the volt scale was now 89·5; *i.e.*, a current of 89·5 micro-ampères was passing through the circuit.

The total resistance of the circuit was therefore

$$\frac{103 \times 10^6}{89{\cdot}5}\,\omega = 1{\cdot}151 \text{ megohms},$$

including the insulation resistance + a few hundred ohms resistance of G_2 and leads.

6.—Description and Calibration of Instruments.

Galvanometers.—As has been already mentioned, these are of the D'Arsonval type, which was chosen on account of its deadbeatness, and more particularly its independence of variations in the surrounding magnetic field. It is hardly too much to say that a system such as that described in this paper depends on the D'Arsonval galvanometer for its existence. The galvanometers are mounted on a stone supported on thick India-rubber rings, an arrangement which has been found to a large extent to stop the transmission of vibrations. The scales are at a distance of 5 feet from the galvanometers.

Calibration of Galvanometer.—Fig. 1 shows the connections and general arrangement. A current is established by means of two or three secondary cells through two suitable rheostats, one having a fixed and the other a variable resistance, the latter made of mercury placed in grooves of a wooden trough with two copper slides. The strength of this current is varied by adjusting the mercury rheostat until the fall of potential across the fixed resistance—"A" on the diagram, fig. 1—the terminals of which are connected with two mercury cups on the instrument table, is equal to the E.M.F. of the standard cell.

When the P.D. between the mercury cups is equal to the E.M.F. of the standard cell no current passes through the second galvanometer, the spot of which will move visibly for a current of 1-ten-millionth of an ampère. As the internal resistance of the standard cell plus the resistance of the galvanometer does not exceed 1,600 ohms, a visible deflection is obtained, one way or the other, if the balance is at fault to the extent of $1{,}600\ \frac{1}{10 + 10^6}$, or ·00016 volts, which is about ·011 per cent. of the value of the standard cell.

The mercury varying but little in resistance by temperature, and giving perfect joints with the copper slides, allows of the resistance

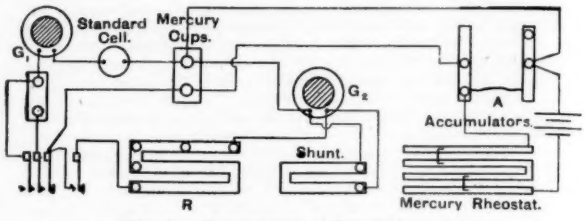

Fig. 1.—Calibrating a Galvanometer.

of the mercury rheostat being adjusted with any desired accuracy, and remaining practically constant when once correctly adjusted. The delicacy of this electrical balance is so great that a movement of $\frac{1}{64}$th inch of one of the slides is sufficient to cause a deflection on the second galvanometer.

This balance is tried for each reading when calibrating a galvanometer.

From the calibration the volt scale was constructed on the white margin immediately below the millimetre scale by simply projecting the points of the readings downwards by means of a set square and dividing up the sections into units.

The calibration of the ampère galvanometer and the manufacture of the ampère scale was done in the same manner as here described.

These calibrations have been repeated several times at intervals, besides which frequent calibrations of mean readings have been taken.

It has been found that the constants of the two galvanometers have not altered beyond $\frac{1}{2}$th per cent. during six months, except on two occasions when the levelling of the instruments had been interfered with.

For purposes like these measurements a D'Arsonval galvanometer should have a glass front to the case, so that the coil is clearly visible, and there should be means of verifying and adjusting the position of the coil in the field. The coil should be wound on a metallic (aluminium) frame, to prevent changes in its shape; and there should be a torsion head outside the cover, so that the original zero of the coil in the field can be restored without opening or interfering with the instrument.

As a slight set crept into the suspending wires of the two galvanometers used in the apparatus, and as they had no arrangement for restoring the zero, it became necessary to turn the instruments on their bases, as the position of the scales could not be altered. The effect of the shifting was hardly marked on one of the instruments, but it caused an alteration in the constant of the other to the extent of 1·2 per cent., and a discrepancy of ·3 per cent. in the proportionality of the scale, which necessitated re-graduating it. An alteration in the constant alone can, of course, at once be balanced by a correction in the resistance used in series with the instrument.

New instruments fulfilling the above conditions are being made.

Main Ampère-Rheostat.—This rheostat, which is marked B on the diagrams, is made of 40 platinoid strips, 6 feet long each, all joined in parallel between two copper terminal bars. The thickness of the strip is ·03 inch; the total width = 38 inches. The cross section is 1·14 square inches; the resistance is ·0010882 legal ohm at 17° C. The total surface of the strips, including the two terminal bars, is 5,854 square inches. When carrying 1,000 ampères 1,088·2 watts are consumed by the rheostat; *i.e.*, power is given off to the atmosphere at the rate of ·186 watt per square inch of surface, which has been found to cause a rise of temperature near the centre of the strips of very nearly 20° C. The rise of temperature in this rheostat has been observed at different currents, and has been found to be proportional to the square of the strength of the current.

Rheostat A.—As is seen from the preceding part of this paper, the accuracy with which currents can be measured in the present system depends upon the knowledge of the value of the resistance of this rheostat. Great care was therefore taken in its manufacture and adjustment. It consists of five strips of platinoid, each intended to carry 10 ampères without material warming. The end of each strip is soldered to a massive gunmetal block let into a wooden frame. These blocks have holes drilled in them about $\frac{3}{4}$ inch in diameter for use as mercury cups. Two heavy strips of gunmetal are let into the frame, one at each end, and there are also holes in these strips opposite the holes in the blocks. The connections are made by thick copper bridge pieces. By this arrangement the strips can be placed either in series or in parallel, and one or more of the strips can be placed in the circuit.

The resistance of each strip is arranged so that the fall of potential across it when a current of about 10 ampères is flowing through it is equal to the E.M.F. of the standard cell.

The absolute resistance of the strips could have varied within certain limits, but it was necessary to adjust the resistance of each to equality with a considerable degree of accuracy. As there was no means of doing this at Thames Ditton, the resistance was taken to the Ordnance Survey, Southampton, and the adjustment made by scraping the strips until their resistances were equal.

* The coils being made of platinoid wire.

The resistance of the five strips in series was then taken at different temperatures, and as there are special arrangements at Southampton for keeping the temperature of the testing room constant, the temperature of the platinoid strips could be accurately determined at the time when each resistance test was taken. The results of these tests are given in fig. 5.

At Thames Ditton the resistance of the strips has been determined from time to time by a direct comparison with the standard ohm in the manner shown in fig. 2. It will be seen that the resistance and

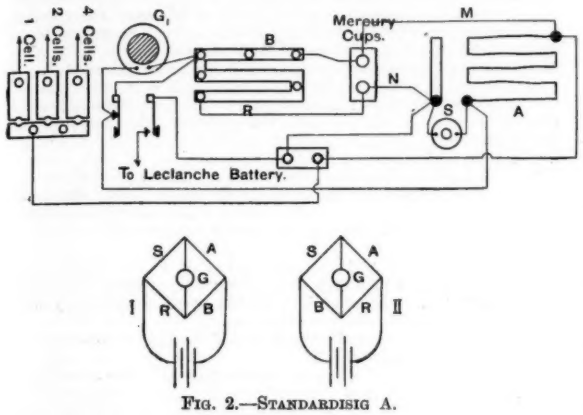

FIG. 2.—STANDARDISIG A.

the ohm form two arms of a Wheatstone bridge arrangement, and boxes of coils the other two arms. The adjustable resistance, R, is first placed in one arm, and then in the other, so that the resistance, A, of the strips is found by the equation,

$$A = S\sqrt{\frac{R_2}{R_1}} \qquad (8)$$

where S = the resistance of the standard ohm at the given temperature; R_1 and R_2 the values of the adjustable coils in the first and second measurements respectively.

The only alterations required in the connections in going from the first of the two tests to the second is the changing of the two leads, M and N, in the mercury cups.

It will be observed that by this arrangement no allowance has to be made for leads, and the absolute resistance of the box of coils is immaterial: true proportionality is only required; thus the temperature of the box of coils does not affect the result.

Fig. 5 shows that the resistance of the five platinoid strips rose from ·7262 ohm to ·7280 ohm for a rise in the temperature from 10° to 22° C., which gives a temperature coefficient of ·0207 per cent. per

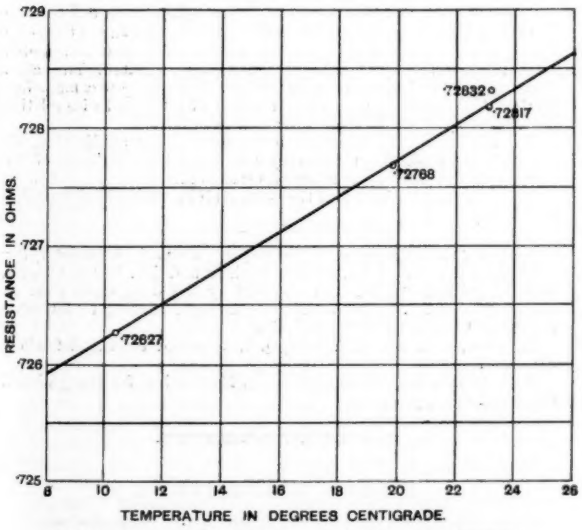

FIG 5.—PLATINOID RHEOSTAT A. (5 STRIPS IN SERIES.)

degree centigrade. At 14·8° C. the value, according to the tests at Southampton, is ·72693. The test at Thames Ditton gave ·72659, leaving a discrepancy of ·047 per cent.

Surface Leakage.—One way of quickly making a test of the state of the instruments is to send a current from the testing cells through the rheostat, B, with the connections as in fig. 3, which, when the instruments are not in use for other purposes, can be done by merely turning on a switch, and read the value of this current on the ampère galvanometer with various constants, altering the resistances in series according to Table I. When this experiment was tried after the instruments had been out of use during the Easter holidays, the galvanometer gave a higher value for the current with constant ·5 than with constant 1, and with constant ·1 still a higher value than with ·5. This discrepancy, which amounted to no less than 3 per cent., was found to be due to surface leakage, which was greater with the higher constant obtained by higher resistance in series. It disappeared completely by a slight rubbing of the top of the resistance boxes with a piece of leather.

The considerable error mentioned was obtained with a current of about 40 ampères, producing a P.D. across the instruments of only about ·043 volt.

DISCUSSION.—NOVEMBER 12TH, 1891.

(*Authorised Abstract.*)

Mr. GISBERT KAPP said he understood that the platinoid sheets of rheostat A were sometimes used five in series and sometimes five in parallel, and he would like to know how the change was effected without introducing unknown resistances?

Prof. AYRTON said he was glad to see that the authors were supporters of the deflectional method of measuring ampères and volts in preference to the zero method so often adopted. He was particularly interested in the matter, for several years ago one of the authors was strongly opposed to deflectional systems; his conversion, he (Prof. Ayrton) considered a great triumph. He was firmly convinced of its superiority, but instead of dwelling on its conveniences, would merely refer the meeting to a communication of Prof. Perry and himself, which was made to the Physical Society early in 1889. The many advantages of D'Arsonval galvanometers as standard ammeters and voltmeters were then set forth, and descriptions of standard instruments given. There were several points in the present paper with which he differed. In the first place, he would like to know why galvanometers of comparatively high resistances were used, and why they were wound with copper? For the current measurements, a low resistance instrument would have been decidedly preferable, and both galvanometers ought to have been wound with platinoid. The ampèremeter would then require no correction for changes of temperature of the room. He enquired whether any special arrangements had been adopted to make the deflections of the galvanometers proportional to the currents? Putting curved pole-pieces on the magnets, and allowing the coil to hang freely from the top suspending wire, would give the desired result. To illustrate the difference in the calibration curves produced by these devices, he showed the calibrations of two originally similar instruments, one of which had been altered as above-described, and the other left untouched. The curve of the former instrument was straight for deflections all across a scale 2 feet 6 inches long within ·015 per cent., whilst in the latter the deviation amounted to about 2 per cent. in the same range.

Replying to a question from Mr. A. P. TROTTER, Prof. AYRTON said the scale distance of the proportional galvanometer was 6 feet. He thought the authors of the paper had overstated the range of their ampèremeter by giving it as from $\frac{1}{10}$th to 1,100 ampères, for the former current only gave a deflection of about one-thousandth of the length of the scale, and therefore could not be measured with any approach to accuracy. Referring to the voltmeter instrument, he enquired whether the error introduced by shunting part of the potentiometer, P, by the galvanometer, and resistance R had been allowed for; in some cases given in Table II. neglecting this would introduce an error of 0·5 per cent. He was of opinion that standard instruments for workshop or factory use should require no constants, and no adjustment of resistances to vary the constant, but that different scales should be used, each graduated to read directly and the resistances altered automatically by the act of changing the scale. Such an arrangement was fitted up three years ago at the Acme Works, six scales being mounted on an hexagonal roller, the turning of which automatically inserted the proper resistance in series with the D'Arsonval galvanometer to make the corresponding scale read ampères or volts direct. Only one scale was visible at one time, so there was no possibility of mistake. Weakening of the magnets was compensated by a magnetic shunt provided with a fine adjustment. Speaking of the change of sensibility of D'Arsonval galvanometers with time, he said that of the two instruments at the Central Institution above referred to, the original form had changed more than three per cent. in the three years, whilst the modified form had remained perfectly constant since the alterations were made about two years ago. The change of sensibility, he believed, was due to the oxidation of the German silver suspension wires, whilst the other instrument, being suspended with phosphor bronze strip, had remained constant.

LEGAL.

The Electric Welding Company.—In the Queen's Bench Division, before Mr. Justice Wills, the case of Nourse *v.* Boland was tried on Thursday, last week, without a jury. Mr. ASQUITH, in opening the case, said the action was one to recover about £3,000 for work done, it was alleged, at the defendant's request and in his interest in connection with securing the sale of certain electrical patents from an American company to an English company which was floated for working in this country. The Thomson-Houston Electric Welding Company of Boston possessed the American and European patents for a process of welding by electricity, and that company dispatched to England two gentlemen, Mr. Lewis and the present defendant, for the purpose of effecting a sale, if they could, of

the English rights to an English Company. The plaintiff introduced Mr. Lewis to Messrs. Russell and Co., a well-known firm of China merchants, with a view to getting them to finance the undertaking. During the negotiations Mr. Lewis left for Paris, leaving Mr. Boland to carry the matter through. Before leaving Mr. Lewis promised the plaintiff that he should be "handsomely remunerated" for his services. The negotiations on behalf of the company were continued, and Messrs. Russell agreed to contribute or get a sum of £20,000 for constructing the experimental works, and, if they proved a success, to get a company to take over the patents. When matters had reached that stage, Mr Boland, without the knowledge of the plaintiff, entered into an arrangement with the City of London Contract Corporation, which undertook to finance the intended company. Although the plaintiff was disappointed at this, he continued on friendly terms with Boland, and gave him every assistance in his power. Altogether he spent the greater part of a year in promoting the undertaking. Eventually an English company was formed, and the question at issue was whether Boland was responsible to the plaintiff to make him some remuneration.

The case was continued on Friday last, and the PLAINTIFF examined by Mr. BIGHAM, stated that his complaint was that this business was taken out of his hands, and he was prevented from earning the five per cent. He went round to his friends soliciting subscriptions, and left initialed application blanks. He understood if they came in he would have the commission. Then he was told his lines interfered with Mr. O'Hagan's (chairman of the Contract Corporation), and he was asked to withdraw all the initialed application forms he had left. He wrote to Mr. Boland, saying he claimed compensation for introducing Lewis and the defendant to Mr. Matheson, whose services had been so valuable to the Electric Welding Company. There was, plaintiff said, a special bargain here. Mr. Lewis promised Russell & Co. not to offer the business to anyone else while in their hands, nor place it before anyone else. Russell & Co. thought Lewis behaved badly to them. He was of opinion his services laid the foundation for the arrangement with the Contract Corporation.

Without making any speech Mr. COWARD called the defendant, Mr. W. A. BOLAND, who explained that when the plaintiff called upon him he offered to introduce him to Russell & Co., but he did not accept the offer as he did not wish to interfere with what Mr. Lewis was doing. Later on he saw Mr. Nourse and told him he had arranged the sale of the patents, and there was nothing he could do in the way of negotiations. He also informed him that he had dismissed Russell & Co. from the matter as they had declined to come forward with any money.

Cross-examined: On the 13th of September he (defendant) saw Russell & Co., and told them the price for the patents was $1,500,000. A letter was received from Russell & Co., afterwards, which contained proposals that could not be accepted.

Re-examined: Matheson's name was never mentioned during the negotiations for the sale of the patents to the Contract Corporation Company.

Mr. O'HAGAN, the chairman of the Contract Corporation, said he first heard of Mr. Matheson some six weeks after they had made the contract to purchase the patents. He was then employed, upon the recommendation of Mr. Boland, to lay the matter before Sir Frederick Bramwell and get his report.

Mr. BIGHAM put Mr. MATHESON into the box to be cross-examined.

In reply to Mr. ASQUITH the witness said he was asked by Mr. O'Hagan to go round and see him. He inferred it was through Russell & Co. He had no knowledge at the time.

Mr. JUSTICE WILLS thought the plaintiff's case had been disposed of, and gave judgment for the defendant with costs.

Hampton and Sons v. The London Electric Supply Corporation, Limited.—In the action of Hampton and Sons *v.* the London Electric Supply Corporation, Limited, the plaintiffs on Wednesday last appealed to the Master of the Rolls and Lords Justices Lopes and Kay from the findings of the Lord Chief Justice on hearing the case with a special jury in May last.

Mr. Jelf, Q.C., and Mr. Lee Roberts were counsel for the appellants, and Mr. Moulton, Q.C., with him Mr. L. E. Pyke, for the respondent company.

The case for the plaintiffs on the trial of the action was that, in response to one of defendants' circulars, offering a supply of the electric light, plaintiffs altered their premises in Pall Mall East, for the reception of the light, and being thus put to a large expense, the company with whom arrangements had been made for 600 lights of 10 candle-power were unable to supply more than 200 lights for one night only. On the trial three questions were put to the jury and answered as follows: (1) Q. Was there a contract? A. Yes. (2) Q. What was it? A. To supply a current up to 600 lights (of 10 candle-power) on the terms embodied in the application form. (3) Q. Had it been broken, and if broken, what are the damages? A. Yes; £175 beyond the sum paid into court. Yet, said Mr. Jelf, the Lord Chief Justice found for the defendants, on apparently the view that although the parties intended there should be a contract and a supply of the light, and although Messrs. Hampton, on the faith of this, expended a large sum of money on the alteration of their premises, it was a contract for an indefinite time, so that it might be put an end to at any moment by either party. He (Mr. Jelf) submitted that on the evidence there was clearly a contract, and the defendants could not put an end to it at a moment's notice, leaving plantiffs in utter darkness. Defendants admitted on the trial that they took steps to carry out the scheme, and gave instructions to their engineer to that effect, but they found themselves unable to supply the current. That they gave plaintiffs 200 lights for one day, he submitted was proof of the contract; for what length of time was another question.

The MASTER OF THE ROLLS: But Hampton being called said they didn't promise the supply.

Mr. JELF submitted that if the Court were against him on this point the correspondence which he read established a contract which was departed from, defendants writing that they found it impossible to give the supply required from their present station at the Grosvenor.

The MASTER OF THE ROLLS wondered how many of these letters were written, and what the Grosvenor Station had to bear.

Mr. MOULTON, Q.C. (counsel for the defendants, with him Mr. Pyke): No doubt the overhead system broke down.

The MASTER OF THE ROLLS: About that time, I think it's better now, whenever you went out to a party the chances were that in the middle of the evening out went the light (laughter). The question, however, here is whether there was such a contract as you could sue upon; and here is the evidence that one of their engines broke down under the heavy pressure just then, in November, required of it.

Mr. JELF said, but plaintiffs had gone to great expense.

The MASTER OF THE ROLLS: We know that people sometimes go to a great expense without having a contract. For how long was your contract?

Mr. JELF said there were two alternatives.

The MASTER OF THE ROLLS, reading the circular, pointed out that there was really no undertaking in it. It made various statements and stated what it was proposed further to do. Plaintiff's application ought to have been in some specific form; but they did not appear to have done this.

Lord Justice KAY: And it seems to me that if they supplied you they might cut it off next day, so far as any agreement is concerned.

Mr. JELF said a reasonable time must be assumed and a jury might say what a reasonable time or notice was.

LORD JUSTICE LOPES: The jury find for £175. I wonder what time they had in their minds?

Mr. JELF: It looks like three months; I don't know. Our claim was for a much larger sum. Defendants having no station anywhere near us had to go to great expense in laying a cable from another place, and so that price was more than doubled. On a continuation of his argument,

The MASTER OF THE ROLLS said: Your contention amounts to this, that you were not bound to take any current from them; but they were bound to supply you.

Mr. JELF said perhaps he had put it too high against himself.

For the respondent defendants, Mr. MOULTON put it that as the Lord Chief Justice had found there was no contract. Each party supposed that self-interest would ensure the one carrying out and the other receiving the supply. Plaintiffs took the risk of defendants not being able to supply, and there being no contract for a specified time they were not legally responsible for their inability to do so; in other words, there was no legal contract. That was his contention before the Lord Chief Justice, and his Lordship's judgment showed that he adopted it.

At the conclusion of the arguments, the MASTER OF THE ROLLS said there was no contract to supply for a definite time—neither a reasonable nor a specific time. That was equivalent to no contract at all—none upon which anybody could sue, and the judgment of the Lord Chief Justice was right.

The Lords Justices concurring in this view, the appeal was dismissed, with costs.

Lane-Fox v. Kensington and Knightsbridge Electric Lighting Company, Limited.—Mr. Justice Romer, in the Chancery Division, heard on Saturday the case of Lane-Fox and Kensington and Knightsbridge Electric Lighting Company, Limited. The action is one for alleged infringement of patent. The case now came before the Court on questions as to the sufficiency of interrogatories relating to the novelty of the invention and other matters.

Mr. WALLACE, who appeared in support of the application, obtained in one instance a fuller reply with respect to a question of the novelty of the patent, but failed on other points.

His LORDSHIP decided that the costs shall be the costs of the other side in any event.

Chase v. Henley's Telegraph Works Company.—This case came before Mr. Justice Mathew and Mr. Justice Charles, in the Divisional Court, on an appeal by the defendants from an order made by Mr. Justice Jeune, in chambers, refusing to set aside a judgment obtained by the plaintiff.

Mr. Ram, with Mr. R. T. Reid, Q.C., appeared for the defendant company.

Their LORDSHIPS, without calling on Mr. Bankes for the plaintiff, dismissed the appeal.

INDIAN TELEGRAPHS.

THE review of the Administration Report of the Indian Telegraph Department shows that Rs. 1,968,580 were added to capital expenditure during the year, the total standing at the close at Rs. 50,241,676 net. The additions to the system were 1,791 miles of line, 7,373 miles of wire, and 21 miles of cable. At the close of the year there were in operation 37,070 miles, 113,512 miles, and 251 miles respectively. 168 new offices have been opened during the year, bringing the number to 3,103. The gross receipts for the year, including State-paid messages, amounted to Rs. 6,828,855, and working expenses to Rs. 4,688,802, showing a profit equal to 4·126 per cent. on capital outlay. The percentages for previous years were 4·34 and 4·45, and the falling off is owing to decreased receipts from foreign telegrams. The receipts from telegraphic money order advices have steadily risen from Rs. 46,000 in 1888, to Rs. 84,000 in 1891. A decrease has

taken place in the cost of signalling, from Rs. 1·03 last year, to ·98 in the current year. The complaints registered were only three per ten thousand messages. The number of undelivered telegrams was about three per thousand.

The review closes—During the year some excellent work was done by the Department in laying field telegraph lines. The Sikkim line was maintained, as also that in the Chin country. A new line in the Assam section of the Chin-Lushai country was laid from Jhalnacherra to Fort Aijal, a distance of 59 miles, through a most difficult and unhealthy country. The other two sections of the line through Lushai, from Demagiri to Fort Tregear, and from Pokoko to Haka, were strengthened. The working parties suffered severely from sickness, one officer losing his life, and another being invalided. For the Hazara expedition 182 miles of extra wire had to be laid to connect Hussan Abdal and Abbottabad with the bases of operations at Derband and Oghi, and from these points onwards, 103 miles of field wire were laid, and 15 offices opened. The services of Mr. Bignell, Mr. Barker, Mr. Pinley, Mr. Thomas and other officers have been warmly acknowledged by the General officers commanding the field forces on these various expeditions, and the Government of India also desires to again record its appreciation of the thorough and able manner in which most useful assistance has been rendered by the Department under very exhausting conditions of climate and trying hardships, all of which these officers have shared in common with the troops employed.

The receipts of the telephone companies at Calcutta, Madras, Bombay, Karachi, Moulmein, and Rangoon, show a small increase of Rs. 10,657, while the number of subscribers is now 1,004, against 961 in the previous year. Additional exchanges at Cawnpore and Mandalay are under supply. A reduction has been made in the rates charged for wires under the management of the Department, and a new and improved form of telephone has been introduced.

The following events of general interest occurred during the year. The Quinquennial International Telegraph Conference was held during June at Paris, the Government of India being represented by Colonel Mallock, late Director-General. No important changes directly affecting the Indian public were introduced. The charges per word between India and the Straits Settlements have been reduced, partly by reductions in the Indian terminal and transit rates, and partly by reductions in the Eastern Extension Company's rates. The transit rate claimable by India for messages passing between Europe and the Far East was largely reduced. Another cable is being laid betwen Suez and Bombay by the Eastern Telegraph Company, and the Eastern Extension Company have added a second cable between Madras and Penang, to replace that on the Elephant Point, Penang route, which has been taken up. By the connection of the French lines in Tonquin with China, a new and cheap route for messages to the latter country, *viâ* Siam, has been opened out.

The Department has been throughout the year administered to the complete satisfaction of the Government of India, by Mr. W. R. Brooke, the Director-General. The Administration Report is submitted nearly a month earlier than that for the previous year.

NEW PATENTS—1891.

19,339. "Facilitating the operations of switching usually carried on in telephone exchanges by means of an improved switching apparatus." R. I. H. PIPPETTE. Dated November 9th.

19,348. "An attachment or means for electrical measuring, sale and delivery, or delivery with measurement only." R. W. BROWNHILL. Dated November 9th.

19,370. "A new or improved device for supporting shades or reflectors for incandescent electric lamps." E. DUNAND. Dated November 9th.

19,385. "Electric lamps applied to bicycles, tricycles, and all velocipedes; also for carriages and any vehicle with or without apparatus to work the same." E. FRANCIS. Dated November 9th.

19,390. "Improvements in dynamo-electric machines and apparatus appertaining thereto." H. G. READ. Dated November 10th.

19,398. "Improvements in or relating to bases for electrical switches." A. HOSTER. Dated November 10th.

19,424. "Improvements in electric globe and shade holders." W. H. PARRY and J. WHITEHEAD. Dated November 10th.

19,450. "Improvements in electric apparatus." T. E. MARSH and WOODHOUSE & RAWSON UNITED, LIMITED. Dated November 10th.

19,458. "Improvements in electric accumulators or storage batteries." W. P. THOMPSON. (Communicated by N. H. Edgerton, United States.) Dated November 10th. (*Complete.*)

19,469. "Improved device for bringing the receiving instruments of telephones against the ears of the person speaking and returning the same to their position of rest, as also for circuiting the telephone in and out." R. GROVE and C. LEHR, jun. Dated November 10th. (*Complete.*)

19,495. "Improvements in machines for making clay conduits for electrical and other purposes." J. J. POWERS and R. VAN BUREN. Dated November 10th.

19,501. "A process for solidifying steel, iron, or other material susceptible to magnetic influence by the application of electrical energy." R. WOODLEY, J. SPEAR and W. HARRIS. Dated November 10th.

19,503. "Improvements in apparatus for electric testing." A. A. DAY. Dated November 11th.

19,504. "Improvements in holders for incandescent electric lamps." F. BRYAN. Dated November 11th.

19,546. "Improvements in alternating current dynamos." W. HARTNELL. Dated November 11th.

19,551. "Improvements in electrical means of advertising." A. R. UPWARD and A. G. BUTTIFANT. Dated November 11th.

19,553. "Improvements in magneto-electric cut-outs or safety apparatus." V. G. LIRONI. Dated November 11th.

19,554. "Improvements in electric switches." V. G. LIRONI. Dated November 11th.

19,617. "Improved exciting fluid for galvanic zinc carbon batteries." M. MUTHEL. Dated November 12th. (*Complete.*)

19,625. "Improvements in ceiling roses and wall sockets for electric lighting." A. GRUNDY. Dated November 12th.

19,630. "Improvements in electric cables." G. G. M. HARDINGHAM. (Communicated by Messrs. Felten and Guilleaume, Germany.) Dated November 12th.

19,635. "An improved electric apparatus for alluring and destroying insects." H. COUNT VON PUCKLER. Dated November 12th. (*Complete.*)

19,666. "Improvements in and connected with the application and utilisation of electricity in the driving of machinery, locomotion and like uses." C. P. SHREWSBURY. Dated November 13th.

19,667. "An improvement in lamps or apparatus connected with electric lighting." C. P. SHREWSBURY. Dated November 13th.

19,691. "An improved device for ozonising air or gas by means of electricity." J. C. LAWSON. Dated November 13th.

19,704. "Improvements relating to the application of depolarisers in electrolysis." J. C. RICHARDSON. Dated November 13th.

19,716. "Improved polar fastening for galvanic elements." J. VON ORLOWSKY. Dated November 13th.

19,744. "Improvements in alternating current machinery." E. W. SMITH. Dated November 14th.

19,775. "Improvements in diaphragms for electrolytic decomposing apparatus." A. BREUER. Dated November 14th.

19,778. "Improvements in electric lighting apparatus." R. A. DAWBARN. Dated November 14th.

ABSTRACTS OF PUBLISHED SPECIFICATIONS, 1890.

16,278. "Improvements in electrical conductors." F. WALTON and H. EDMUNDS. Dated October 13th. 4d. Relates to a flexible tube of good condncting metal, such as copper, made by coiling helically a strip of the metal, corrugated in such a way that the convolutions interlock. This tube is covered externally with insulating material, and this may be protected by armouring. Within the tube are laid several bare conducting wires, which being in contact with each other and with the tube simply add to the conducting area. 1 claim.

20,712. "Improvements in and relating to electric batteries." E. ORTELLI. Dated December 18th. 8d. The improved battery is based upon the principle that metalloids of the first class, namely, bromine, chlorine, fluorine, and iodine, combine with hydrogen and form with it at the ordinary temperature powerful acids which are very soluble in water and attack nearly every metal, producing hydrogen. The inventor employs in this case chlorine, as being the most appropriate for his object, and being produced or bought at a low price. 8 claims.

CORRESPONDENCE.

Theory of Solution.

A recent number of the ELECTRICAL REVIEW contains some criticisms on my "Electrical Theory of Solution." As it seems to me that the objections are due to a misapprehension of the theory, I have written this note to explain more fully those portions to which Mr. Pickering objects.

First, I would say that I entertain a very high opinion of Mr. Pickering's work (though, perhaps, one may think his differentiations carried a little too far), and that one of the chief merits of my theory, in my own estimation, is the fact that it reconciles the results obtained by Mr. Pickering with those of the dissociationists.

Briefly stated, the theory as given in my previous papers, is as follows :—

1. The space between two atoms of a solid is small compared with their diameters, as shown by the contraction of K Cl.

2. There is a stress between the atoms of any portion of matter.

3. Which is an electrostatic stress.

4. It varies as the size of the atoms and the square of the distance between their centres, in the same way as an electrostatic stress naturally would.

5. The same quantity of electricity is on each equivalent atom, its potential alone varying.

6. The phenomena of rigidity, cohesion, surface tension, and cohesive force of gases, &c., are caused by this electrostatic attraction.

The theory of the particular case with which we are at present concerned is as follows :—

When a solid is placed in a solvent, the stress between the molecules of the solid being greater than that between the molecules of the solvent, it tends to become equalised, and the molecules of the solid lose part of their charge, while the molecules of the solvent gain, till both have the same voltage. But as we have seen by 6, the cohesion of molecules is due to this stress, and therefore, since it is much weakened, the solid will no longer have cohesion. That is, since the electrostatic attraction is small in comparison with the repulsive effect due to the kinetic energy of the molecules, it now behaves exactly as a gas. For, since a gas is merely matter in such a condition that—

Repulsive force due to motion of molecules > than cohesive force due to electrostatic attraction—it is evident that we can obtain the same result in either of two ways.

1. By increasing the velocity of the molecules, *i.e.*, by heating the substance.

2. By diminishing the attractive force, *i.e.*, by solution.

In the same manner as by a still further increase of the kinetic energy of the atoms of the molecule by heat we produce dissociation, so in the same way by still further dilution we may accomplish the same result.

It is, of course, evident that if the electrostatic attraction between the atoms of the fluid is the same as that between the particles of the solid, no solution or disassociation will take place, while if it is less the solid will dissolve the fluid.

The principal objection raised by Mr. Pickering is that since :—

1. When a substance is turned to a gas it necessitates an absorption of energy.

2. Therefore if a substance when dissolved becomes a gas, the solution should be cooled.

3. But it is heated.

Therefore the disassociation theory must be wrong. Nos. 1 and 3 are undoubtedly correct ; but 2 is not.

The reason is that we are not dealing with the dissolved substance alone, but with the dissolved substance and the solvent. As explained in a former paper, the solvent takes up the stress.

A mechanical simile will make my meaning clear : Suppose a spiral spring, A, fixed on a board, C, which when compressed gives out heat from some reversible cause, so that it will absorb the same amount of heat in expanding. This is similar to the behaviour of a gas — when compressed it gives out heat, when it expands again it absorbs

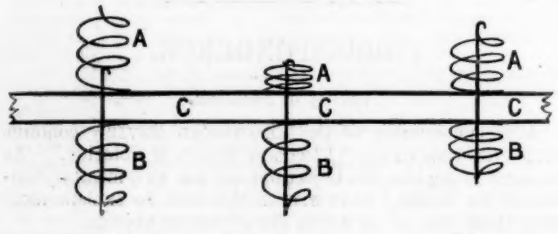

FIG. 1. FIG. 2. FIG. 3.

heat. But now suppose a second spring, B, placed beneath the board, C, similar in every respect to the first spring, and its axis a prolongation of that of A. Suppose an iron rod fastened to the bottom of C extending up the centre of both springs, the rod being somewhat longer than one of the extended springs, and having a hook on the end of it.

In fig. 1 both springs are extended. In fig. 2 the spring, A, is compressed, heat being given out. If it is now allowed to expand, the same amount of heat will be absorbed. This represents the turning of a solid into a gas by heating it.

But suppose, being compressed, the iron rod is hooked over the top of it. Then when it is let go it will expand and assume the position of fig. 3. But no heat will be generated in the system, for it is evident that B will give out just as much as A absorbs.

If the amount of heat given off by unit contraction of A were greater than that given off by B, the resultant effect would be a cooling of the system. If it were less the resultant would be a heating. So we see, that while the expansion of A by itself would always absorb heat, when it is joined to a spring, B, the resultant effect depends on B.

Now, this is a very fair simile of what goes on when a solid is dissolved in a solvent. The solid loses its stress, which is taken up by the solvent, the result being an increase of cohesion between the molecules of the solvent, producing as a natural consequence increase of surface tension, lowering of the freezing point, and raising of the boiling point.

If the added electrostatic strain produces a greater amount of heat in the solvent than the loss of strain in the solid would absorb heat, the resultant would be a heating of the whole solution.

Since, when a dissolved substance is plated out by electrolysis, the result resembles the cutting of the iron rod, D, in fig. 3, there is an absorption of energy or cooling, so that work must be done to plate the dissolved substance out, and the electromotive force necessary to do this, since the ampères are constant for all equivalents, must depend on the rate at which the surface tension varies per withdrawal of unit weight of the electrolysed substance, allowing, also, for any heating or cooling during the electroplating.

After all, the chief evidence in favour of a theory is its ability to predict results, and I consider the fact that my prediction that the cohesive force of gas was due to an electrostatic attraction, of the same nature as that I had already shown to cause tensile strength of metals, has been verified within three months of its publication by Mr. Chattock (*Phil. Mag.*, September, 1891) is in its favour. Moreover, in the formula for rigidity of metals,

$$\text{Rigidity} = \frac{2{,}800}{(\text{Atom. Vol.})^2}$$

there was one exception, iron, which was too high. Recent determinations show that for pure iron the rigidity of iron is much less, and should be about 540, and not 750, as generally given.

Reginald A. Fessenden.

The Magnetic Lady.

Science cherishes the profound, but treats with disdain a mystery. The shy goddess, though she may close her eyes to a catalysis, wink at an ambiguity, or smiles on what is vague, never plays the coquette with necromancy.

In what follows, an attempt is made to treat scientifically, a matter of general and magnetic moment. Since reading the letter contained in your last issue with regard to the performance of Miss Abbott, I have gathered what other information I could, in order to bring this magnetic lady, as it were, "up to date."

By an original application of what may be termed "*device* of leaster squares," I have arrived at a formula which would seem to give, at once, her "locus," and "figure of merit." Let y = some function of A λ,

We have $$dy = \text{A}\lambda \int_{\text{K}}^{\text{P}} d\theta \qquad = \overline{\text{A}\lambda\theta}\Big|_{\text{K}}^{\text{P}}$$

Integrating now between the limits of possibility, P, and credulity, K, we find the *locus* of the magnetic lady to be at the $\text{A}\lambda\theta$. The "figure of merit" is of three dimensions, and would require a transcendental expression involving spherical trigonometry.

Further than the $\text{A}\lambda\theta$ it would be absurd to go ; for anyone who cares to investigate, however, an empire lies beyond. Experiments alone will give them help. For instance, I would suggest that the "billiard" phenomenon could be studied, and its "polarity" determined, by a large application of Gauss's formula, as used above, and the "*Kew* observation magnetometer." We could then find B, p, and H. No doubt the law of inverse square would, in some way or other, be found to fit.

I hope to read a most interesting paper on this subject before the B.A. next year.

R. A. (Jo. King.)